TP 4386E

VICTORIA STOLPORT EVALUATION

by

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February, 1983

The contents of this report reflect the views of the contractor and not necessarily the official views or policies of the Transportation Development Centre.

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17. Abstract

This study reports on the reactivation of the Victoria STOLport for a short take-off and landing aircraft service scheduled to begin in fall 1983. The Victoria STOLport was constructed on a site previously used as a landfill area from the early 1900's until 1965.

In 1977-78 an environmental engineering study was carried out in order to report on settlement rates, subsurface material characterisation and flow rates. This report (1982-83) analyses quantitatively the settlements that have occured since 1978, the strength of the original paved areas, gaseous emissions and environmental impact.

The findings are that the settlement rate is less than predicted in 1977-78, the paved areas subject to a minimal overlay are suitable for STOL-aircraft operation and the existing building foundations are reusable, subject to some positive means of gas control.

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17. Résumé

Ce rapport traite de la remise en service de l'adacport Victoria prévue pour l'automne 1983, adacport établi sur un emplacement ayant servi de dépotoir entre le début des années 1900 et 1965.

En 1977-1978, cet emplacement avait fait l'objet d'une étude géotechnique qui s'était attachée à mesurer les tassements du terrain, à caractériser le sous-sol de l'emplacement et à vérifier le régime d'écoulement des eaux d'infiltration. Le présent rapport (réalisé en 1982-1983) chiffre l'amplitude des tassements depuis 1978, la portance des chaussées établies à l'origine, ainsi que les émissions gazeuses et l'impact sur l'environnement.

Le rapport conclut que les tassements ont été inférieurs à ce qui avait été prévu en 1977-1978, que le revêtement existant se prête à l'exploitation d'un service d'avions à décollage et atterrissage courts, sous réserve de recevoir une nouvelle couche d'usure d'épaisseur minimale et que les fondations de l'ancienne aérogare pourraient servir à nouveau, à condition que soit mis en oeuvre un dispositif efficace pour la maîtrise des émissions gazeuses.

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APPENDIX I

Inspec-Sol report on topographic survey, settlement rate and pavement strength testing.

APPENDIX II

IEC Beak report on gas monitoring and environmental requirements.

APPENDIX III

Gionet, Mellor, Liebich Associates report on foundations Victoria car park - STOLport hangar and terminal buildings.

VICTORIA STOLPORT
EVALUATION REPORT

1. INTRODUCTION

1.1 Background

In the Fall of 1983, Canavia Transit Inc./City Centre Airways Ltd. intend to introduce a STOL service utilizing the existing Victoria STOLport in Montreal. It is the intent to utilize the de Havilland Dash 7 aircraft, thereby introducing the first commercial STOL service in Canada.

A condition of the license is that the operator restore the Victoria STOLport in Montreal to an operational status. The Victoria site, a former land fill area, was used by the Transportation Development Centre up to 1976 for a STOL demonstration research project.

In 1977-1978 an environmental engineering study was carried out at the site by Beak Consultants Limited and Inspec-Sol Inc. This study included extensive assessments of land fill settlements, subsurface material characterization, gaseous emission characterization and flow rates together with recommendations for construction features necessary to ensure a safe site. Recognizing that further settlements and deterioration of the paved areas would have taken place over time, this evaluation is a follow-up to the 1977-1978 environmental engineering study and sets out to review and update the results of that study. The results of this evaluation are set out in this report.

1.2 Purpose of Study

The purpose of this study and report is to implement the following work tasks:

- topographic survey of runways, taxiways, and aprons to determine settlements since the previous study.

- analysis of settlement rates.

- testing and evaluation of strengths of the above areas and develop load/deflection curves.

- comparison and evaluation of settlements with respect to subsurface material decomposition and gas generation, and recommend programs for on-going and future work respecting gas monitoring and environmental activities.

- evaluation of existing building piles and concrete rafts.

- report on suitability of land fill sites for STOL operations.

1.3 Study Team

The Consultants engaged by Canavia Transit Inc./City Centre Airways Limited were:

- IBI Group
- Inspec-Sol Inc.
- IEC Beak Consultants Limited
- Gionet Mellor Liebich Associates Limited

The Transportation Development Centre appointed Mr. T. Smith as Project Officer.

The IBI Group was responsible for the inter-consultant liaison and liaison between Canavia Transit Inc./City Centre Airways and the Transportation Development Centre. The IBI Group was also responsible for the Capsule Report and issue of the Evaluation Report.

Inspec-Sol Inc. was responsible for the topographic survey, geotechnical analysis of settlements and pavement load strength determination.

IEC Beak Consultants Limited was responsible for the geochemical analysis and interpretations, plus recommendations for gas monitoring and environmental issues.

Gionet Mellor Liebich Associates Limited was responsible for the evaluation of existing building piles and concrete rafts.

1.4 Study Approach

The approach was to conduct a topographic grid survey over the runway, taxiway and parking apron using the original grid of the 1977-1978 study. The limits of this survey was extended 30 metres beyond the edges of the three paved areas. Geotechnical and geochemical comparisons were then made between the results of the 1977-1978 study and the present, and conclusions drawn.

Plate bearing tests were performed on strategically choosen runway, taxiway and apron areas in order to determine the inherent strength of the existing pavement, and the results related to the Transport Canada pavement load rating method for easy comparison.

An examination of terminal and hangar buildings foundation was carried out to determine their suitability for reuse.

2. FINDINGS

2.1 Assessment of Settlement Rates

A detailed assessment of the settlement rates is included in Appendix I. The findings are that the settlement rate observed in November, 1982, is equal to, or substantially lower than, the 1978 prediction of 3-6 mm/month. It appears therefore that the surface is tending towards stabilisation.

Significantly higher settlement magnitudes have been experienced on the western half of the runway relative to the eastern half. This

tends to substantiate the 1978 theory of uncontrolled dumping, waste placement and higher organic content garbage at the west half of the runway, and this has resulted in higher settlement magnitudes.

The western half of the apron which interfaces with the hangar is experiencing settlements which are above the site average. Possible reasons for this are surface features such as drainage pattern and cracks, plus differing pavement thickness across the apron, and non-continuous membranes below grade, which have contributed to the downward seepage of run-off water. This condition would result in an increase in decomposition activity within the waste materials.

The actual average settlement rate experienced between September 1978 and November 1982 ranges from 1 to 3 mm/month. This should translate into approximately 300 mm of additional settlement over the next 12 years at which time the settlement rate is expected to be 1 mm/month.

There are several localized areas which display anomalies or localized departures from the average performance. This makes settlement predictions for these areas virtually impossible. These localized areas occur at:

- runway chainage 115 + 50 - old CN sewer trench.
- western half of apron and taxiway.
- bump at Runway chainage 103, bump at Apron south-east quadrant.
- asphalt cracking and movement of the fill in the area of chainage 123 + 00 to 124 + 00 on the north edge of the runway.

These anomalies are mapped out on the enclosed Drawing No. 5457-1 in Appendix IA. They will continue to persist unless corrective measures of some nature are taken to counteract the subgrade condition.

Further testing at these local areas would be required before definite corrective methods can be recommended. However, it would appear

that these anomalies are related to one or a combination of the following:

- back fill material in trench not homogenous with adjacent materials.
- difference in pavement thickness across the apron.
- local hard spots such as large boulders below the subgrade.
- absence or breakdown of impervious layers allow the downward seepage of water into the waste layers.

Should further testing confirm the above, the followng corrective measures could be employed. Re-excavate bumps and ridges and fill and compact with granular material similar to the adjacent areas. Install or repair impervious layer to stop the downward seepage of water into the waste material.

One area of the site which has displayed a significantly higher settlement rate is the western half of the hangar entrance apron. Settlements of between 250 to 300 mm have been recorded between September 1978 and November 1982. This is the highest rate of settlement on the site and approaches the maximum predicted settlement rate of 6 mm/month in the 1978 study.

Special treatment such as some type of transition slab will therefore be required between the interface of the apron and the hangar and to a lesser extent the terminal building, to make up the differential settlement between the rigid building slabs and the moving pavement. Indeed, a major deficiency of the original design was the omission of some type of mechanism that would take up the obvious differential settlement between a rigidly supported slab and a moving pavement, without too much reconstruction.

2.2 Assessment of Plate Bearing Tests

A detailed report on the methodology used for the plate bearing tests is included in Appendix IB.

According to drawings provided by Transport Canada, there are three pavement design thicknesses on the STOLport aircraft traffic areas as follows:

Pavement Type A - Main Parking Apron

63.5 mm asphalt

230 mm granular base

1140 mm granular sub-base fill
impervious material
composite membrane

Variable common fill.

Pavement Type B - Runway and Taxiway

63.5 mm asphalt

230 mm granular base

770 mm (min) granular sub-base fill
impervious and previous materials

3 to 5 meters common granular fill

Pavement Type E - Western Entrance to Former Hangars

63.5 mm asphalt

150 mm granular base

300 mm granular sub-base

Variable common fill.

In completing the analysis of the plate bearing test results, Transport Canada - Air, Pavement Design Manuals (6, 7, 8) were used. The Dash 7 aircraft loading and landing gear data was obtained from the de Havilland Aircraft of Canada Ltd. characteristics manual as well as from Transport Canada Manual AK-68-30-100(7).

In accordance with Design Manual AK-68-30-100(7) the Dash 7 aircraft has an Aircraft Load Rating (A.L.R.) of 5 and requires a Pavement Load Rating (P.L.R.) of 5 or greater.

A detailed analysis of plate bearing strengths (see Appendices 1 and IB) indicate the following pavement load ratings:

Runway P.L.R. 11

Taxiway P.L.R. 10

Apron P.L.R. 6-7

In every case the ratings are higher than that required by the design aircraft.

It would appear that continuing overall settlement of the surface has not affected the inherent strength of the pavement in a significant way.

2.3 Review of Gas Monitoring and Environmental Requirements

A detailed review of the gaseous emissions, gas monitoring and environmental requirements is set out in Appendix II.

It was stated earlier that the settlement rate over the recent four years has occurred at a lower rate than that projected in the 1977-1978 study. However, settlement is continuing indicating on-going decomposition of the underlying material, gaseous emissions have and are expected to continue. This was underlined by continuing emissions through detectable odours at points on the site, specifically at formerly active flares and in the vicinity of the building foundations.

Keeping the on-going emissions in mind this review has resulted in no changes to the recommendations given in the 1977-1978 study.

The on-going gas monitoring recommended in Section 5.6.2 of the 1977-1978 study appears not to be implemented. Since upgrading the site to active STOL operations now seems likely, it appears timely to give this recommendation more active consideration.

The STOLport site is one of a number of sites on which the Federal Government is focussing effort in the area of receiving water contamination by toxics. Through implementation of the gas monitoring program set forth in the referenced section 5.6.2 of the previous report, an opportunity would exist to monitor leachates and ground water in the site for those specific parameters of concern from an environmental point of view which may require control or mitigative measures in the future.

2.4 Assessment of Existing Terminal and Hangar Building Foundations

The original buildings consisted of one-storey buildings constructed on piled foundations. The removal of the superstructures have left the original floor slab supported by columns sitting on a pile cap. There is a crawl space between the bottom of the floor slab and the top of the pile cap. Between the floor slab and the pile cap are the remains of a flexible membrane installed to prevent gaseous emissions from entering the building.

The floor slabs show no unusual cracking, spalling, premature aging or other signs of distress.

The flexible membrane is rented in various places and would require total replacement. Damage to the membrane appears to have occurred because of the demolition of the superstructure rather than by natural causes.

The piling consists of concrete filled steel piles which have a virtually unlimited life expectancy.

The existing foundations appear structurally sound and therefore suitable to receive new superstructures provided that the original design loads are not exceeded.

Should the existing foundation slab prove to be too small for the proposed new terminal building, careful design attention would have to be

given to the support of the added slab, to prevent differential movement between the existing and the added slab. The most effective way to limit differential movement would be to support the added slab on piles in a similar way to the existing slab. Also, the flexible membrane installed between the existing floor slab and pile cap to prevent gaseous emissions from entering the building, would have to be extended to cover the area under the added slab.

Another alternative that should be investigated if a larger terminal building is required, would be the design of a two storey building. The weight of such a building would have to be within the design capability of the existing foundations, and the height would have to meet STOLport side zoning criteria.

Careful attention must be given to the control of methane gas emissions and adequate preventative measures taken prior to the reconstruction of new superstructures.

3. CONCLUSIONS

3.1 Runway and Taxiway

Average settlement rates of 1-3 mm/month are expected to continue for approximately 10 years before significant reductions in the rate will be realized. These rates are considered tolerable and should easily be rectified by periodic localized asphalt patching. A complete asphalt overlay may be required every five years to provide a uniform grade and smooth riding surface. As the pressent asphalt pavement structure has been found acceptable to carry the Dash 7 loading, all that is required is a complete re-grading of the asphalt to provide a new wearing course which eliminates the uneven grade. Several anomalies require special attention and probable sub-grade treatment to minimize future occurrences of the same surface blemish.

3.2 Apron

The eastern half of the apron, which interfaces with the terminal building, is performing in a similar way to the east end of the runway and is expected to continue to do so for the next 10 years. A new asphalt wearing surface should be added to improve smoothness and to correct anomalies. Periodic asphalt patching will be required at the asphalt/terminal interface to correct settlements.

The western half of the apron, which interfaces with the hangar and the taxiway, is displaying settlements which are above the site average. A severe depression has developed near the junction of the apron and taxiway as well as in front of the hangar. This area will require significant filling and re-grading in order to match the grades of adjacent asphalted areas and the hangar slab.

A major omission of the original design was some kind of transition accommodation between the interface of the fixed surfaces and the settling surface. A transition surface of some kind will therefore have to be designed between fixed surfaces such as the floor slabs and hydrant pads and the settling surface so as to limit the step in the surface at these interfaces caused by differential settlement.

It is thought that one reason for the poor performance of this area of the site is the concentrated drainage pattern which has developed across the surface. Another possible cause is the differing thicknesses of pavement structures, interrupted asphalt patterns and non-continuous membranes below grade in this area. All of these factors could contribute to increased downward seepage of run-off waters in this zone, a situation which results in an increase in decomposition activity within the waste materials in a more aerobic atmosphere.

3.3 Environmental Engineering Study

Recommendations contained in the Environmental Engineering Study (1979) by Beak Consultants Limited with respect to gas control are in order and stand. Existing building slabs and foundations should be upgraded to include their original gas control devices, ensuring integrity of membranes and floor slabs, and including positive pressure systems.

Recommendations in the 1979 report vis-a-vis gas control and monitoring in building structures are applicable, without change, to the new proposed builldings.

Site gas monitoring facilities were recommended in 1979, and have not been implemented. These are again recommended, both for gaseous emission monitoring and for potential measurement of leachate characteristics, due to recent concern for possible receiving water (rivers, lakes) contamination.

3.4 Terminal and Hangar Building Foundations

The existing foundations appear structurally sound and are therefore suitable to receive a new superstructure, providing of course, that the original design loads are not exceeded in the new design.

Before construction of any new buildings on the foundations, careful attention must be given to the control of methane gas emissions. Remedial action such as the re-installation of a new flexible membrane or clay seal along with some "positive - active" means of gas control (i.e. mechanical ventilation) must be instituted before any structural works can be contemplated.

3.5 General Conclusions

Although no initial bearing strength tests are available for comparison, the inherent structural strength of the pavement seems largely

unaffected by the settlement. This surmise can be supported by the fact that the pavement was designed for loadings similar to the Dash 7 and the recent tests indicate P.L.R. readings in excess of the Dash 7 requirements.

From the findings of the Environmental Engineering Study (January, 1979) by Beak Consultants Limited, and the findings of this study, it has been ascertained that the settlement pattern and gaseous emissions of land fill sites can be predicted with some accuracy. One major structural problem of such sites would be differential settlements. This can be alleviated to a certain extent through controlled dumping and compaction of the garbage and other waste.

The waste layer should be protected by some impervious medium to stop the downward seepage of runoff water in order to prevent an increase in decomposition activity within the waste materials which result in increased gaseous emissions and accelerated settlement rates. If the seepage is localized, settlement rates outside the norm could occur.

Land fill sites can be utilized as airports provided there is sufficient knowledge of the behaviour characteristics of the site; gas control measures, particularly those under and adjacent to buildings, are adequate; and, some deformation of the surface is tolerable.

APPENDIX I

February 3, 1983

CANAVIA TRANSIT INC.

Montreal STOLport Evaluation Report,
Transportation Development Centre,
File No. D-1455-101-18

INSPEC-SOL INC. 5762 Royalmount, Montréal, Québec H4P 1K5, Tél: 731-7316

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Appendices

1.0 INTRODUCTION

Inspec-Sol Inc. has undertaken to conduct an analysis of the settlement rates and structural capacities of the runway, taxiway and parking apron at the Victoria STOLport as Part of Transportation Development Centre Research mandate dated November 24, 1982. Inspec-Sol worked in collaboration with I.E.C. Beak Consultants Ltd. and the I.B.I. Group in conducting this STOLport evaluation for Canavia Transit Inc./City Centre Airways Ltd. who are planning to operate a commercial STOLport Service from the facility beginning in 1983.

This engineering evaluation is a follow-up to an Environmental Engineering Study (1) carried out at the site by Inspec-Sol Inc. and Beak Consultants Ltd. for Transport Canada in 1977-1978.

The purpose of this study and report is therefore:

a) To analyse quantitatively the land fill settlements which have occurred since the 1978 Environmental Engineering Study in order to compare the actual site performance to the report prediction and theories. This analysis is limited to the asphalted aircraft traffic areas only.

b) To analyse, by means of in-situ plate bearing tests, the asphalt pavement strengths (over the taxiway, apron and runway) in order to confirm sufficient pavement strength and capabilities for the Dash 7 aircraft.

2.0 FIELD PROCEDURES

2.1 Topographic Survey

A topographic grid survey was conducted over the runway, taxiway and parking apron in front of the former terminal and hangar buildings in order to compare 1982 elevations with those recorded in the 1978 Environmental Engineering Study. The limits of this 1982 survey extended 30 m (100 feet) beyond the edges of asphalt on the three areas. The benchmark and site stations were identical to those used to prepare the 1978 report.

The benchmark is located on the south-west corner of the hangar slab and has an elevation of 21 312 mm (69.92 feet). The hangar slab is supported by piles which are founded on bedrock according to available information. Movement of the slab and benchmark can therefore be neglected in the settlement analysis and the stability of the benchmark was verified in our 1978 report.

This grid survey was performed before the frost had set into the ground between the dates of November 24-30, 1982 and was carried out on a 15 m (50 foot) interval. The elevations were used to update the settlement drawing presented in the 1978 report (Drawing No. E1322-26) to show magnitudes of land fill settlements across the entire site from the end of construction in November 1973 until 1977, 1978 and November 1978. This drawing has been converted to S.I. units and is presented as on Drawing No. 5457-1 in Appendix A.

During our topographic survey, we also mapped out the major cracks and settlement anomalies as they appeared in November 1982. This information, along with the 1978 surface anomalies, is presented on the site plan Drawing No. 5457-1 in Appendix A.

2.0 FIELD PROCEDURES (Cont'd)

2.2 Pavement Strength Testing

According to drawings provided by Transport Canada, there are three pavement design thicknesses on the STOLport aircraft traffic areas as follows: (2)

Pavement Type A - Main Parking Apron

63.5 mm asphalt
230 mm granular base
1140 mm granular sub-base fill
impervious material
composite membrane
Variable common fill

Pavement Type B - Runway & Taxiway

63.5 mm asphalt
230 mm granular base
770 mm (min.) granular sub-base fill
impervious and pervious materials
3-5 meters common granular fill

Pavement Type E - Western Entrance to Former Hangars

63.5 mm asphalt
150 mm granular base
300 mm granular sub-base
Variable common fill

The common fill used to level out and build up the pre-STOLport grade was a stone screenings, which according to our findings in the 1978 borehole investigation, varied from 3 to 5 meters thick over the runway and taxiway. The screenings were also used to provide a levelling layer over the pre-STOLport grade and build up the runway surface to a level 280 mm below final grade. Sand was used to protect the synthetic membrane and a clean stone layer was used to form a porous zone to collect and disperse methane gases from below the membrane.

2.0 FIELD PROCEDURES (Cont'd)

2.2 Pavement Strength Testing (Cont'd)

Five (5) in-situ plate bearing test locations were strategically chosen to analyse various aspects of these pavement design thicknesses, as well as to obtain information regarding zones of the site which were known to display a variation in settlement rates and magnitudes. The plate bearing test locations are shown on the STOLport site plan Drawing No. 5457-2 in Appendix B along with Borehole and Test Pit Locations from the 1978 Environmental Engineering Study.

These test locations are as follows:

Test No.	Date	Location	Site Grid Location	Pavement Type
1	Nov. 25/82	Parking Apron East Side	E 124+00 N 7+75	A
2	Dec. 2/82	Runway Centre Line - East End	E 121+50 N 5+00	B
3	Dec. 2/3/82	Runway Centre Line - West End	E 105+00 N 5+00	B
4	Dec. 3/82	Taxiway	E 120+80 N 6+40	B
5	Dec. 3/82	Apron West Side	E 122+00 N 7+75	A

2.0 FIELD PROCEDURES (Cont'd)

2.2 Pavement Strength Testing (Cont'd)

Plate bearing tests were conducted in accordance with the recommended A.S.T.M. procedures for Evaluation and Design of Airport and Highway Pavements. The tests were conducted between the period of November 24 to December 4, 1982 on the asphalt surface in all test locations as well as on the granular sub-base material in the case of test location No. 4 on the taxiway. Copies of these two standard testing procedures are enclosed at the end of Appendix B, Enclosure Nos. B22-B-27 inclusive.

The testing program commenced by using the repetitive test procedure D-1195 (3) and a 762 mm (30") diameter plate on Test No. 1. However, the recorded plate deflections were very small (1.8 mm at 233 kN and 2.1 mm at 272 kN) and the load so high, that the dump truck used for the dead load was being lifted off the ground during the jacking procedure. The remainder of the tests (2-5) were therefore conducted using the non-repetitive test method D-1196 (4). Two smaller plate diameters of 254 mm (10") and 610 mm (24") were used at each of the four locations in order to evaluate if there was a marked strength difference by using the large or small plate.

At Test No. 4 on the taxiway, an excavation was made through the asphalt and granular base to expose the sub-base material 350 mm (14") below the asphalt. This sub-base material was a stone screenings having a gradation of 0-5 mm. A 254 mm diameter plate was used to perform a sub-base bearing test at this depth.

At each test location, four (4) cores were drilled through the asphalt in order to record the thickness. In addition to these asphalt cores, compaction tests were performed in the base and sub-base course granular materials at Load Test No. 4 in order to obtain in-situ densities. Samples were taken of both materials for laboratory grain size analysis and Proctor density testing. Results of these tests are contained in Appendix B, Enclosure Nos. B-17 to B-20 inclusive.

3.0 SETTLEMENT ANALYSIS

3.1 Settlement Rates

Transcribing the 1982 topographic survey results into magnitudes and rates of settlement results in the following Table No. 1 for secondary compression of the land fill waste along the Runway Centre Line. Secondary compression is that settlement resulting from organic material decomposition within the waste and is deemed to have started in June 1974, 6 months after completion of runway construction (1).

TABLE NO. 1

Secondary Settlement Rates (mm/month)
Runway Centre Line

Time Months	Date	Chainages 109+00	115+50	120+00	123+00	125+00
0	Nov. 73	End of Runway Construction Primary Compression				
6	June 74	Secondary Compression Began				
15	Feb. 75	10	7.6	0.9	4.0	0
20	July 75	7.0	4.3	0	2.7	6.0
48	Nov. 77	6.7	6.0	0.9	2.1	2.4
58	Sept. 78	2.4	4.9	0.12	3.0	1.2
108	Nov. 82	3.0	3.3	0.9	2.1	0.9
Secondary Settlement: (mm)		509 = (1.67')	478 = (1.57')	58 = (.19')	157 = (.515')	116 = (.38')

3.0 SETTLEMENT ANALYSIS (Cont'd)

3.1 Settlement Rates (Cont'd)

The 1978 settlement rate prediction was 3-6 mm/month. The rates between September 1978 and November 1982 are thus equal to, or substantially lower than the 1978 predictions. The differential settlement rates on the western half of the runway (ch. 109+00 and 115+00) as compared to the eastern half continue to manifest themselves thus substantiating the theory presented in our 1978 report that the method of dumping and lack of control in waste placement, higher organic content and differing ages of land fill on the west and east result in much more rapid settlement rates and significantly higher settlement magnitudes on the more recent west end land fills.

TABLE NO. 2

Average Pavement Settlement Rates

Period		Runway Chainages 100 to 110	110 to 118	118 to 125	Taxiway	Apron
June 74 to Nov. 77 (41 months)	Δ Total mm	222.5	274.3	79.3	94.5	188.9
	Rate mm/mo.	5.8	7.1	2.03	2.28	4.57
Nov. 77 to Sept. 78 (10 months)	Δ Total mm	15.2	48.8	18.3	27.4	12.4
	Rate mm/mo.	1.52	4.88	1.83	2.74	12.5
Sept. 78 to Nov. 82 (50 months)	Δ Total mm	143.2	173.7	73.1	103.6	176.8
	Rate mm/mo.	2.7	3.5	1.4	2.1	3.5
Nov. 77 to Nov. 82	% Change in Rate	-53%	-50%	-31%	-3%	-23.4%

3.0 SETTLEMENT ANALYSIS (Cont'd)

3.1 Settlement Rates (Cont'd)

The remainder of the 1982 survey results display similar trends for the taxiway and apron settlements. Table No. 2 summarizes the overall performance of the runway (divided into 3 sections) the apron and taxiway since June 1974 which is the beginning of secondary compression after runway construction.

One area of the site which has displayed a significantly higher magnitude of settlement is the western half of the hangar entrance apron and a portion of the taxiway link between the apron and the runway. This settlement of the asphalt in this area had resulted in a major series of open cracks on the apron area. The asphalt surface to the west of these cracks, which are mapped out on the enclosed Drawing No. 5457-1, slopes down at an abrupt rate. Settlements of between 250 - 300 mm have been recorded between September 1978 and November 1982 (50 months). This is the highest rate of settlement on this site during this study period and approaches the maximum predicted settlement rate of 6 mm/mo. in the 1978 study. The rate appears, in fact, to have accelerated since 1978.

The use of the present hangar, and to a lesser degree the terminal facility, will be slightly jeopardized by the anomaly due to the interface between the rigid building slabs and the moving asphalt. The asphalt surface in front of the hangar area will require frequent adjustment to accomodate this rapid movement.

There are three pavement design thicknesses used by Transport Canada over the three zones analysed. These have been discussed in greater detail in Section 2.2, Pavement Strength Testing. However, the thinnest pavement thickness exists on the western half of the hangar entrance where the most settlement has been recorded during this study period. There is no borehole date available on this area of the hangar ramp to enable correlation of land fill quality with granular cover. It is recommended that further subsoil and pavement strength studies be performed in this area in order to permit economic decisions to be made regarding improvements required to the pavement structures at this location.

3.0 SETTLEMENT ANALYSIS (Cont'd)

3.2 Prediction of Future Movements

The 1978 settlement rate prediction of 3-6 mm per month appears to have been somewhat pessimistic as the actual rate was 1-3 mm/month referring to Table No. 2, Section 3.1. This is a 30-50% reduction in settlement rate on the runway as compared to the settlement rate experienced during the first 4-5 years after construction (1974-1978). The same relative reductions can be expected over the next 10-15 year life span. The long term prediction of 250 months for secondary compression to reach a minimal or "0" value still appears to be in the correct order of magnitude and 1994 is still considered the target date for this condition. We are of the considered opinion that the settlement will not reach a "0" value but rather will reduce to a nominal uniform settlement rate of say 1 mm/month at best.

The maximum anticipated secondary compression due to decomposition of the land fill organics has been quantified by Yen and Scanlon (5) as presented in the 1978 Environmental Engineering Study (1). In that analysis, it was assumed that approximately 1/2 of the anticipated maximum secondary settlement took place prior to STOLport construction. It is believed that this theory is still valid.

However, the maximum value for secondary compression of land fills was estimated to be 4.5 to 6.0% of the land fill thickness. The magnitudes of settlement realized to date (509 mm versus 670 mm predicted at chainage 109+00 and 157 mm versus 405 mm predicted at chainage 123+00) appear to contradict this estimate of the total settlement. This is most likely due to the influence of the heavy surcharge load of the fill placed for the STOLport grading. The maximum anticipated settlement is now expected to be between 6 and 10% of the total thickness of fill based on past performance. This translates into approximately 300 mm of additional settlement over the next 12 years at which time the settlement rates are expected to be less than 1 mm/month (1/2 inch per year).

3.0 SETTLEMENT ANALYSIS (Cont'd)

3.2 Prediction of Future Movements (Cont'd)

No prediction is possible for these areas on site which continue to display anomalies or localized departures from the average performance. This is entirely a random occurrence. There is however a reasonable pattern established for these anomalies as follows:

a) Runway chainage 115+50 - Old CN Sewer Trench

b) Western half of Apron & Taxiway

c) Bump at Runway chainage 103
Bump at Apron south-east Quadrant

d) Asphalt cracking and movement of the fill in the area of chainage 123-124 on the north edge of the runway.

These anomalies are mapped out on the enclosed Drawing No. 5457-1 in Appendix A. They will continue to persist unless corrective measures of some nature are taken to counteract the sub-grade condition.

3.3 Plate Bearing Test Analysis

Inspec-Sol obtained and used Transport Canada-Air, Pavement Design Manuals (6, 7, 8), in completing the analysis of the plate bearing test results. Presentation of findings has, as much as possible, followed the format presented in these manuals in order to facilitate comprehension and analysis by others.

The Dash 7 aircraft loading and landing gear data has been obtained from the Dehavilland Aircraft of Canada Ltd. characteristics manual as well as from the Transport Canada manual AK-68-30-100 (7). The Dash 7 aircraft has an Aircraft Load Rating (A.L.R.) of 5 and requires a Pavement Load Rating (P.L.R.) of 5 or greater in accordance with Design Manual AK-68-30-100 (7).

3.0 SETTLEMENT ANALYSIS (Cont'd)

3.3 Plate Bearing Test Analysis (Cont'd)

Our analysis of the plate bearing strengths indicates the following pavement load ratings:

Runway	P.L.R.	11
Taxiway	P.L.R.	10
Apron	P.L.R.	6-7

A summary of the plate bearing test results is given in Appendix B on Enclosure No. B-1 along with detailed analysis of the Runway on Enclosure No. B-2, the Taxiway on Enclosure No. B-3 and the Apron on Enclosure No. B-4.

Individual plate bearing test field data is contained on Enclosure Nos. B-5 & B-6 for load test No. 1 (repetitive method) and on B-7 through B-16 for test Nos. 2-5 (non-repetitive method).

In analysing the existing pavement "equivalent granular thickness", two alternatives were used. In the first instance, consideration was given to the fact that at least 1370 mm of granular material exists below the asphalt due to the screening material which was used as common fill below a granular base course 230 mm thick. This alternative produced an equivalent thickness of approximately 1 440 mm. The sieve analysis for the screenings indicates "0" frost susceptibility as a subgrade material according to the recommended grading chart from Manual AK-68-12 for Spring Reduction Factor Determination (see Enclosure B-21). However, due to a slightly higher percentage passing No. 75 mm sieve, the material was classified as SP, poorly graded sand for which a Spring reduction factor of 20% was applied [1].

1 Table 5, Manual AK-68-31

3.0 SETTLEMENT ANALYSIS (Cont'd)

3.3 Plate Bearing Test Analysis (Cont'd)

In the second instance, only the base course granular thickness was considered (230 mm) to provide an "equivalent granular thickness" of approximately 300 mm over the same "SP", poorly graded sub-grade screenings material and the 20% Spring reduction factor was also applied. This first analysis is the one presented on Enclosure No. B-1. The only difference in P.L.R. obtained is on the taxiway, where the value was 6 for 1450 mm equivalent granular thickness and 7 for a 300 mm equivalent granular thickness, both of which exceed the required P.L.R. of 5 for the Dash 7 Aircraft.

In many of the plate bearing tests, the recorded test deflections were very small utilizing small plate diameters (254 mm) which are not listed on Table 4 of Document AK-68-12. Plate conversion factors should therefore be higher in 5 of the 9 non-repetitive test results shown on Enclosure B-7. This fact results in a conservative P.L.R. value.

The existing pavement structures are therefore considered sufficient to carry the Dash 7 aircraft and the existing pavement structures and the pavement rating are all in excess of the P.L.R. of 5 for the aircraft.

3.4 Pavement Thickness Analysis

From the Transport Canada design drawings (2), the pavement thicknesses on the runway, taxiway and apron are identical being:

Asphalt	6.5 cm
Granular Base	22.8 cm
Total	29.3 cm

3.0 SETTLEMENT ANALYSIS (Cont'd)

3.4 Pavement Thickness Analysis (Cont'd)

The asphalt thicknesses were confirmed at each test location (see Enclosure B-20) and the granular base was confirmed at load test No. 7 on the taxiway (29.2 cm thick).

Tire pressure ranges for the Dash 7 are as follows:

Low Pressure Optional Tires	.393 - .482 MPa
Standard Tire	.531 - .738 MPa

The present pavement thickness is acceptable for the low pressure optional tires in accordance with Table 1, Document AK-68-12-320. 2.5 centimeters of additional asphalt would be required for the standard tire pressure. The existing granular base is acceptable as built for the Dash 7 aircraft.

4.0 CONCLUSIONS

4.1 Runway & Taxiway

Average settlement rates of 1-3 mm/month are expected to continue for approximately 10 years before significant reductions in the rate will be realized. These rates are considered tolerable and should easily be rectified by periodic localized asphalt patching. A complete asphalt overlay may be required every five years to provide a uniform grade and smooth riding surface. As the present asphalt pavement structure has been found acceptable to carry the Dash 7 loading, all that is required is a complete re-grading of the asphalt to provide a new wearing course which eliminates the uneven grade. Several anomalies require special attention and probable sub-grade treatment to minimize future occurrences of the same surface blemish.

4.2 Apron

The eastern half of the apron which interfaces with the terminal building is presently performing similar to the east end of the runway and is expected to continue to do so for the next 10 years. A new asphalt wearing surface should be added to improve smoothness and correct anomalies. Periodic asphalt patching will be required at the asphalt/terminal interface to correct settlements.

The western half of the apron which interfaces with the hangar and the taxiway is presently displaying settlements which are above the site average. A severe depression has developed near the junction of the apron and taxiway as well as in front of the hangar. This area will require significant filling and re-grading in order to match the grades of adjacent asphalted areas and the hangar slab.

4.0 CONCLUSIONS (Cont'd)

4.2 Apron (Cont'd)

It is thought that one reason for the poor performance of this sector of the site is the concentrated drainage pattern which has developed across the surface. Another possible cause is the differing thicknesses of pavement structures, interrupted asphalt patterns and non-continuous membranes below grade in this area. All of these factors could contribute to increased downward seepage of run-off waters in this zone, a situation which results in an increase in decomposition activity within the waste materials in a more aerobic atmosphere.

As no qualitative testing has been conducted below grade in this area, we would strongly urge that an investigation program be conducted in order that appropriate steps may be taken and surface coverings designed to counteract the phenomenon.

4.3 General

Complete construction and grading design recommendations for site improvement prior to implementing the STOL Service are beyond the scope of this report. It is strongly advised that any fill materials placed on the STOLport site will result in increased settlement activity due to surcharge loading of the land fill. A close collaboration between the Airport Planning Consultants and this firm at the design stage would be beneficial to the long term performance and stability of the new STOLport facility.

LIST OF REFERENCES

1. Environmental Engineering Study, STOLport Site, Victoria Carpark, Montreal.
   Prepared for Transport Canada - Air by Beak Consultants and Inspec-Sol Inc., January 1979.

2. Transport Canada Design Drawing Q-108-4, Montreal STOLport, Construction Details, Revision 1 13.4.73.

3. American Society for Testing and Materials, Test Method D-1195-64 (reapproved 1977).
   Repetitive Static Plate Load Tests of Soils and Flexible Pavement Components for use in Evaluation and Design of Airport and Highway Pavements.

4. American Society for Testing and Materials, Test Method D-1196-64 (reapproved 1977).
   Non-Repetitive Plate Load Tests of Soils and Flexible Pavement Components for use in Evaluation and Design of Airport and Highway Pavements.

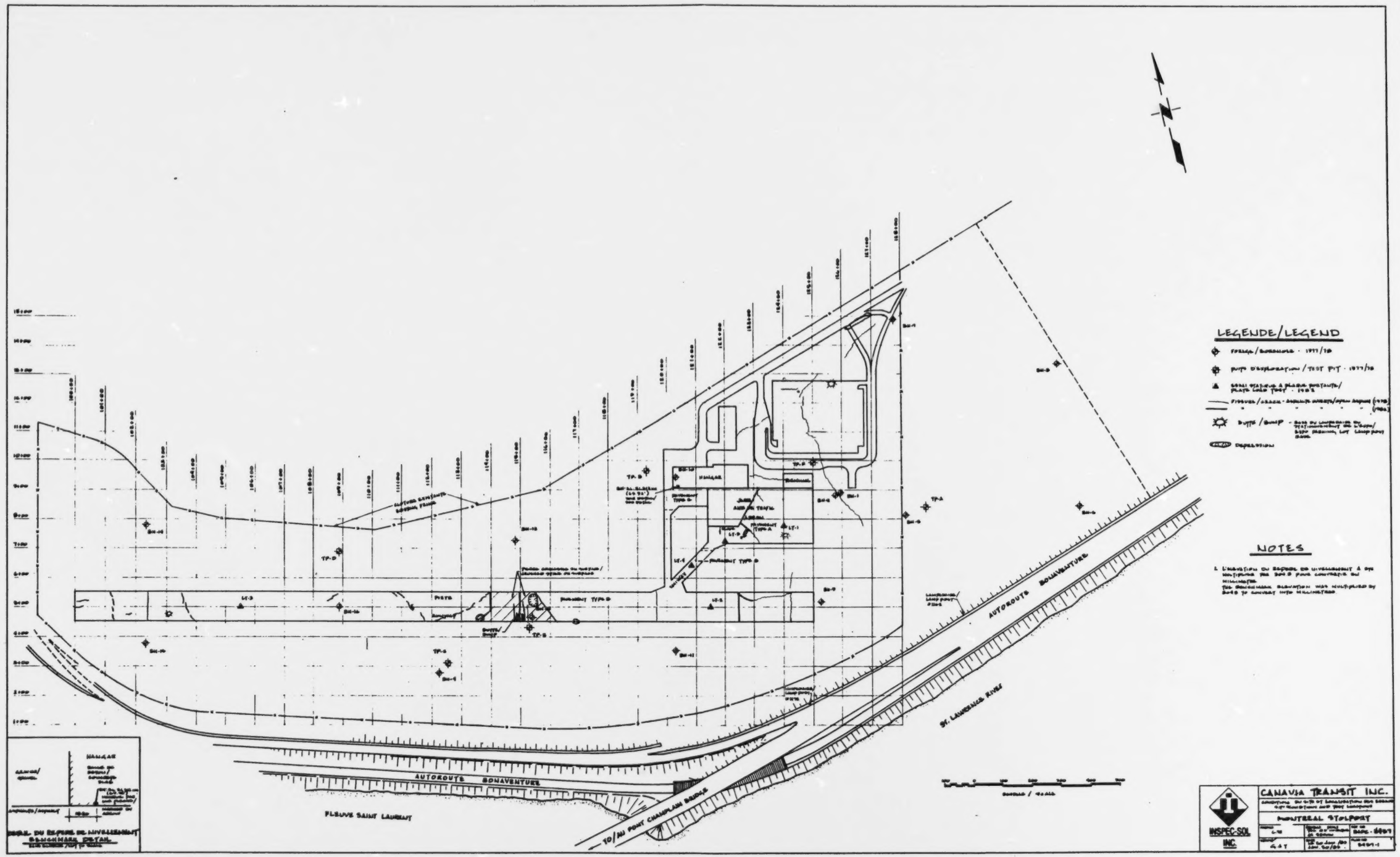
5. Yen, B.C. and Scanlon, B. "Sanitary Landfill Settlement Rates", Journal of the Geotechnical Engineering Division, ASCE, Vol. 101, No. GT 5, May 1975, p. 475.

6. Pavement Bearing Strength and Analysis, Design Manual No. AK-68-12, Transport Canada - Air.

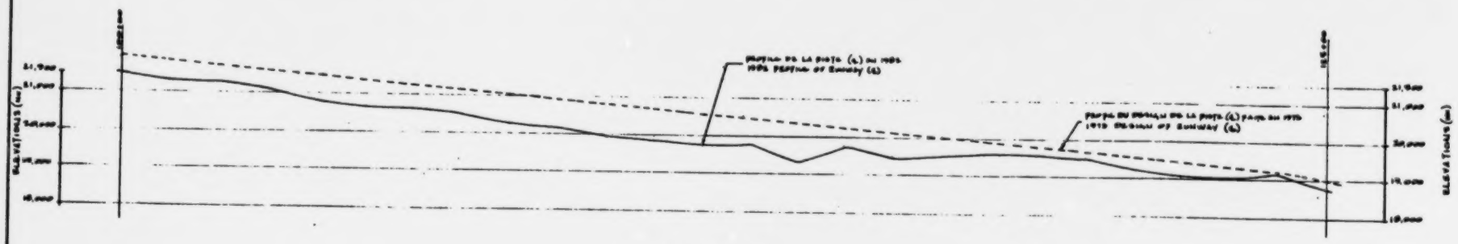
7. Pavement Evaluations for Aircraft Loadings, Design Manual No. AK-68-30-100, Transport Canada - Air.

8. Pavement Design & Rehabilitation, Design Manual AK-68-12, Transport Canada - Air.

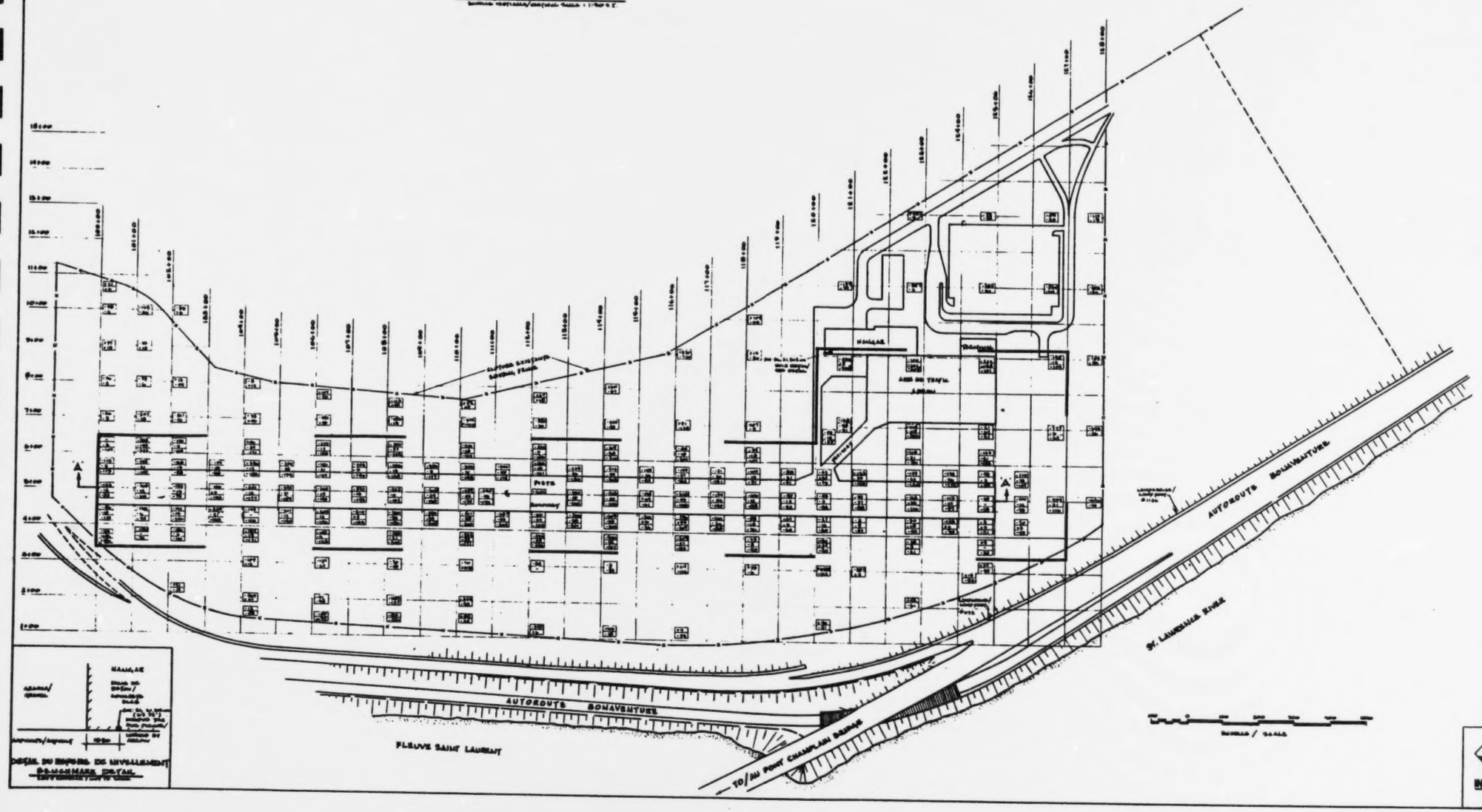
APPENDIX IA


LEGENDE/LEGEND
NOTES
AUTOROUTE BONAVENTURE
FLEUVE SAINT LAURENT
ST. LAWRENCE RIVER
TO/TO PONT CHAMPLAIN BRIDGE
HANGAR
PISTE
PAVEMENT TYPE B
PAVEMENT TYPE A
CANAVIA TRANSIT INC.
MONTREAL STOLPORT
INSPEC-SOL INC.

APPENDIX IB



COUPE/SECTION A-A



DETAIL DU PROFIL DE NIVELLEMENT
BANQUISE TYPIQUE

LEGENDE/LEGEND

NOTES

CANAVIA TRANSIT INC.

MONTREAL STOLPORT

INSPEC-SOL INC.

SUMMARY OF PLATE BEARING TEST RESULTS

Client: Canavia Transit Inc.
Project: Victoria STOLport, Montreal, Quebec

Location (Temp.)	Test No.	Chainage (Date of Test)	Plate Ø mm	Type Test (Note 1) / Stratum	Equivalent granular thickness "t" (cm)	Surface "S" (kN) (Note 2)	Sub-grade "S" (kN) (Note 3)	Slq (Note 4)	Spring Reduced Slq (Red. Fact. 20%) (Note 5)	P. L. R (Note 6
Runway (5 to 7° C)	2	E 121 + 50 N 5 + 00 (Dec. 2, 1982)	254	N / Sur	144.5	> 1335	174	$\bar{X}$ = 118.8	69.3	11
			610	N / Sur	144.5	> 632	82	δ = 47.7		
Runway (2 to 5° C)	3	E 105 + 50 N 5 + 00 (Dec. 2&3, 1982)	254	N / Sur	144.5	> 1098	143	SLQ= 86.6		
			610	N / Sur	144.5	> 582	76			
Taxiway (9 to 12° C)	4	E 120 + 80 N 6 + 40 (Dec. 3, 1982)	254	N / Sur	138.1	557	84	$\bar{X}$ = 104.0	68.0	10
			610	N / Sur	138.1	829	124	δ = 28.3		
			254	N / Sub	138.1	----	> 867*	SLQ= 84.9		
Apron (0 to -2°C)	1	E 124 + 00 N 7 + 75 (Nov. 25, 1982)	762	R / Sur	137.9	702	98	$\bar{X}$ = 53.0	21.3	6
Apron (12° C)	5	E 122 + 00 N 7 + 25 (Dec. 3, 1982)	254	N / Sur	138.7	> 190	27	δ = 39.1		
			610	N / Sur	138.7	245	34	SLQ= 26.1		

NOTES:
1. Type Test: N = Non-Repetitive R = Repetitive Stratum: SUR = Surface SUB = Subgrade
2. For derivation of surface "S" see Enclosures Nos. B-5 & B-7
3. "S" Subgrade = "S" Surface X $10^{-t/145}$
4. SLQ (Lower Quartile Subgrade Strength = $\bar{X}$ -0.6755δ
5. Spring Reduced SLQ = SLQ X 0.80 (Transport Canada Air Manuel AK-68-12-200, Table 1).
6. P.L.R. (Pavement Load Rating) from figure 5, AK-68-30-100-) Transport Canada Air Manual.
7. ">" indicated a MINIMUM value.

* This value disregarded for calculation purposes.

Report No. 310C-5457 Enclosure No. B-2

ANALYSIS OF LOAD TEST DATA & STRENGTH CODING

Client: Canavia Transit Inc.

Project: Victoria STOLport, Montreal, Quebec

Location: Runway

TEST NO.	THICKNESS (cm)			EQUIVALENT THICKNESS t (cm)	BEARING STRENGTH (kN) (762 mm 0, 10 reps., 12.5 mm deflection)	
	ASPHALT	BASE	SUB-BASE		SURFACE	SUBGRADE
2A	6.2	22.9	109.2	144.5	> 1335	174
2B	"	"	"	"	> 632	82
3A	"	"	"	"	>1098	143
3B	"	"	"	"	> 582	76
			Average "t"	144.5	Average $\bar{x}$	118.8
					Standard Deviation σ	47.7

t = (Asphalt thickness x 2.0) + Base Thickness + Sub-base Thickness

Subgrade Strength = Surface Strength x $10^{-t/165}$

Lower Quartile Bearing Strength = $\bar{x}$ - 0.6755 σ = 86.6 kN

Spring Reduction Factor = 80%

Spring Reduced Lower Quartile Bearing Strength = 69.0 kN

PAVEMENT LOAD RATING (from Table 5, AK-30-100, Prepared by Transport Canada)

With t = 144.5 cm and s = 69.0 kN: P L R = 11.0

INSPEC-SOL INC.

Report No. 310C-5457

Enclosure No. B-3

ANALYSIS OF LOAD TEST DATA & STRENGTH CODING

Client: Canavia Transit Inc.

Project: Victoria STOLport, Montreal, Quebec

Location: Taxiway

TEST NO.	THICKNESS (cm)			EQUIVALENT THICKNESS t (cm)	BEARING STRENGTH (kN) (762 mm 0, 10 reps., 12.5 mm deflection)	
	ASPHALT	BASE	SUB-BASE		SURFACE	SUBGRADE
4A	6.0	22.9	109.2	138.1	557	84
4B	"	"	"	"	829	124
4C	"	"	"	"	-	7 867 *
			Average "t"	138.1	Average $\bar{x}$	104.0
					Standard Deviation σ	28.3

* This value has been disregarded for calculation purposes.

t = (Asphalt thickness x 2.0) + Base Thickness + Sub-base Thickness

Subgrade Strength = Surface Strength x $10^{-t/165}$

Lower Quartile Bearing Strength = $\bar{x} - 0.6755\,\sigma$ = 84.9 kN

Spring Reduction Factor = 80%

Spring Reduced Lower Quartile Bearing Strength = 68.0 kN

PAVEMENT LOAD RATING (from Table 5, AK-30-100, Prepared by Transport Canada)

With t = 138.1 cm and s = 68.0 kN: P L R = 10.0

INSPEC-SOL INC.

Report No. 310C-5457

Enclosure No. B-4

ANALYSIS OF LOAD TEST DATA & STRENGTH CODING

Client: Canavia Transit Inc.

Project: Victoria STOLport, Montreal, Quebec

Location: Apron

TEST NO.	THICKNESS (cm)			EQUIVALENT THICKNESS t (cm)	BEARING STRENGTH (kN) (762 mm Ø, 10 reps., 12.5 mm deflection)	
	ASPHALT	BASE	SUB-BASE		SURFACE	SUBGRADE
1	5.8	22.9	109.2	137.9	702	98
5A	6.6	22.9	109.2	138.7	> 190	27
5B	6.6	22.9	109.2	138.7	245	34
			Average "t"	138.4	Average $\bar{x}$	53.0
					Standard Deviation σ	39.1

t = (Asphalt thickness x 2.0) + Base Thickness + Sub-base Thickness

Subgrade Strength = Surface Strength x $10^{-t/165}$

Lower Quartile Bearing Strength = $\bar{x} - 0.6755\,\sigma$ = 26.6 kN

Spring Reduction Factor = 80%

Spring Reduced Lower Quartile Bearing Strength = 21.3 kN

PAVEMENT LOAD RATING (from Table 5, AK-30-100, Prepared by Transport Canada)

With t = 138.4 cm and s = 21.4 kN: P L R = 6

INSPEC·SOL INC.

Report No. 310C-5457 Enclosure No.B-5

REPETITIVE STATIC PLATE LOAD TEST RESULTS

Client: Canavia Transit Inc.

Project: Victoria STOLport, Montreal, Quebec

DATE 1982	TEST NO.	LOCATION (CHAINAGE)	LAYER	PLATE (Ø mm)	NO. OF LOAD REP	PLATE LOAD IN kN AT DEFLECTION (mm) OF							
						1.25	2.50	5.00	7.50	10.00	12.50	15.00	17.50
Nov. 25	1	E 124+00 N 7+75	Surf	762	1	239.0							
					10	153.0	271.0				702 equiv.		
					100	132.0	237.0						
					1000								

- Corrected deflections are plotted against repetitions of load (figure A-10, Appendix A, Document AK-68-31). Deflections at 1, 10, 100, 1000 repetitions are extrapolated from this graph.
- These are used to construct a graph of corrected deflection against magnitude of load for each number of repetition (figure 6-A, Appendix A, Document AK-68-31).
- Load is then extrapolated from this graph for various deflection and repetitions.
- Read load at maximum deflection-convert to 12.5 mm deflection using load ratios given in Table 31, AK-68-31.

INSPEC-SOL INC. - All documents referred to were prepared by Transport Canada.

Enclosure No. B-5

Report No. 310C-5457 Enclosure No. B-6

REPETITIVE LOAD TEST DATA SHEET

Client: Canavia Transit Inc. Project: Victoria STOLport, Mtl, Que.

Load Test No.: 1 - Surface Location: E 124+00 N 7+75

Date of Test: November 25, 1982 Temperature: 0 to -2°C

Equipment: 762, 610, 432, 305, 254 mm Ø plates, various shims

Equipment Dead Weight:	2.1	kN
Seating Load:	118.0	kN
TOTAL:	120.1	kN
Zero Load:	59.0	kN
Plus Dead Weight:	2.1	kN
CORRECTED ZERO LOAD:	61.1	kN

FIRST LOAD:	231.0	kN
Plus Dead Weight:	2.1	kN
CORRECTED FIRST LOAD:	233.1	kN

APPLICATIONS	1	2	3	4	5	6	7
CORRECTED DEFLECTION	1.171	1.451	1.611	1.705	1.781	1.857	
MEASURED DEFLECTION	1.041	1.321	1.481	1.575	1.651	1.727	
DIAL CORRECTION	0.130	0.130	0.130	0.130	0.130	0.130	

SECOND LOAD:	270.3	kN
Plus Dead Weight:	2.1	kN
CORRECTED SECOND LOAD:	272.4	kN

APPLICATIONS	1	2	3	4	5	6	7
CORRECTED DEFLECTION	2.022	2.124	2.200	2.264			
MEASURED DEFLECTION	1.892	1.994	2.070	2.134			
DIAL CORRECTION	0.130	0.130	0.130	0.130			

Dial Correction is calculated as per Figure 4-A, Appendix A, Document AK-68-31 prepared by Transport Canada. This figure is added to the measured deflection to obtain the corrected deflection.

All deflections are in millimeters.

INSPEC-SOL INC.

NON-REPETITIVE STATIC PLATE LOAD TEST RESULTS

Client: Canavia Transit Inc.

Project: Victoria STOLport, Montreal, Quebec

DATE 1982	TEST NO.	LOCATION CHAINAGE	LAYER	PLATE Ø (mm)	PLATE LOAD IN kN AT DEFLECTION			PLATE CONVERSION FACTOR *	P762 Ø 12.5mm D, 10 rep (kN)
					1.25mm	2.50mm	5.00mm		
Dec. 2	2A	E121+50 N 5+00	Surface	254	115	231		> 5.78	> 1335
"	2B	"	"	610	215			> 2.941	> 632
"	3A	E105+50 N 5+00	"	254	94.5	190		> 5.78	> 1098
"	3B	"	"	610	198			> 2.941	> 582
Dec. 3	4A	E120+80 N 6+40	"	254	43.5	87.0	(defl.3.75mm) 131	4.255	557
"	4B	"	"	610	142	28.2		2.941	829
"	4C	"	Subgrade	254	74.5	150		> 5.78	> 867
"	5A	E122+00 N 7+25	Surface	254	14	28	55	> 3.448	> 190
"	5B	"	"	610	38	76	(defl.3.75mm) 114	2.151	245

- Corrected deflections are plotted against corrected loads, (figure 3-B, Appendix B, Document AK-68-31).
- Extrapolate maximum deflections and use load ratios from Table 4*, Document AK-68-31 to convert to standard 762mm. Ø plate, 10 repetitions, 12.5mm. deflection .
- NOTE: In many cases, load ratios are MINIMUMS since deflections are very small for smaller plate diameters , thus the equivalent "P" are also minimums denoted by > (ie. the value is greater than that stated).

INSPEC-SOL INC.

Report No. 310C-5457

Enclosure No. B-8

NON-REPETITIVE LOAD TEST DATA SHEET

Client: Canavia Transit Inc. Project: Victoria STOLport, Mtl, Que.

Load Test No.: 2A - Surface Location: E 121+50 N 5+00

Date of Test: December 2, 1982 Temperature: 6 to 7°C

Equipment: 254 mm Ø plate, various shims

Equipment Dead Weight: 0.7 kN

LOAD NO.	LOAD			DEFLECTION		
	DIAL (kN)	DEAD WEIGHT (kN)	CORRECTED LOAD (kN)	DIAL (mm)	DIAL CORRECTION (mm)	TRUE DEFLECTION (mm)
Seating Load	34.4	0.7	35.1			
Zero Load	17.2	"	17.9			
1	24.6	"	25.3	0.102	0.190	0.292
2	49.2	"	49.9	0.381	"	0.571
3	73.7	"	74.0	0.610	"	0.800
4	98.3	"	99.0	0.838	"	1.028
5	122.9	"	123.6	1.118	"	1.308
6	147.5	"	148.2	1.397	"	1.587
7	172.0	"	172.7	1.664	"	1.854
8	196.6	"	197.3	1.981	"	2.171
9	221.2	"	221.9	2.286	"	2.476

Dial Correction is calculated as per Figure 3-B, Appendix B, Document AK-68-31 prepared by Transport Canada. This figure is added to the dial reading to obtain the true deflection.

INSPEC-SOL INC.

Report No. 310C-5457 Enclosure No. B-9

NON-REPETITIVE LOAD TEST DATA SHEET

Client: Canavia Transit Inc. Project: Victoria STOLport, Montreal, Que.

Load Test No.: 2B - Surface Location: E 121+50 N 5 + 00

Date of Test: December 2, 1982 Temperature: 6 to 7°C

Equipment: 610, 432, 305, 254 mm Ø plates, various shims

Equipment Dead Weight: 1.7 kN

LOAD NO.	LOAD			DEFLECTION		
	DIAL (kN)	DEAD WEIGHT (kN)	CORRECTED LOAD (kN)	DIAL (mm)	DIAL CORRECTION (mm)	TRUE DEFLECTION (mm)
Seating Load	49.2	1.7	50.9			
Zero Load	24.6	"	26.3	0		
1	49.2	"	50.9	0.084	0.060	0.144
2	98.3	"	100.0	0.381	"	0.441
3	147.5	"	149.2	0.737	"	0.797
4	196.6	"	198.3	1.049	"	1.109

Dial Correction is calculated as per Figure 3-B, Appendix B, Document AK-68-31 prepared by Transport Canada. This figure is added to the dial reading to obtain the true deflection.

INSPEC-SOL INC.

Report No. 310C-5457 Enclosure No.B-10

NON-REPETITIVE LOAD TEST DATA SHEET

Client: Canavia Transit Inc. Project: Victoria STOLport, Montreal, Que.

Load Test No.: 3A - Surface Location: E 105+50 N 5+00

Date of Test: December 2, 1982 Temperature: 2 to 5°C

Equipment: 254 mm Ø plate, various shims

Equipment Dead Weight: 0.7 kN

LOAD NO.	LOAD			DEFLECTION		
	DIAL (kN)	DEAD WEIGHT (kN)	CORRECTED LOAD (kN)	DIAL (mm)	DIAL CORRECTION (mm)	TRUE DEFLECTION (mm)
Seating Load	34.4	0.7	35.1			
Zero Load	17.2	"	17.9			
1	24.6	"	25.3	0.121	0.270	0.931
2	36.9	"	37.6	0.216	"	0.486
3	49.2	"	49.9	0.400	"	0.670
4	73.7	"	74.4	0.673	"	0.943
5	98.3	"	99.0	1.080	"	1.350
6	122.9	"	123.6	1.346	"	1.616
7	147.5	"	148.2	1.689	"	1.959
8	172.0	"	172.7	2.057	"	2.327
9	196.6	"	197.3	2.337	"	2.607

Dial Correction is calculated as per Figure 3-B, Appendix B, Document AK-68-31 prepared by Transport Canada. This figure is added to the dial reading to obtain the true deflection.

Report No. 310C-5457 Enclosure No. B-11

NON-REPETITIVE LOAD TEST DATA SHEET

Client: Canavia Transit Inc. Project: Victoria STOLport, Montreal, Que.

Load Test No.: 3B - Surface Location: E 105+50 N 5+00

Date of Test: December 2, 1982 Temperature: 8°C

Equipment: 610, 432, 305, 254 mm Ø plates, various shims

Equipment Dead Weight: 1.7 kN

LOAD NO.	LOAD			DEFLECTION		
	DIAL (kN)	DEAD WEIGHT (kN)	CORRECTED LOAD (kN)	DIAL (mm)	DIAL CORRECTION (mm)	TRUE DEFLECTION (mm)
Seating Load	24.6	1.7	26.3			
Zero Load	12.3	"	14.0			
1	19.7	"	21.4	0.079	0.065	0.144
2	39.3	"	41.0	0.229	"	0.294
3	59.0	"	60.7	0.368	"	0.433
4	78.6	"	80.3	0.508	"	0.573
5	98.3	"	100.0	0.648	"	0.713
6	122.9	"	124.6	0.775	"	0.840
7	147.5	"	149.2	0.889	"	0.954
8	172.0	"	173.7	0.991	"	1.056

Dial Correction is calculated as per Figure 3-B, Appendix B, Document AK-68-31 prepared by Transport Canada. This figure is added to the dial reading to obtain the true deflection.

INSPEC-SOL INC.

Report No. 310C-5457

Enclosure No.B-12

NON-REPETITIVE LOAD TEST DATA SHEET

Client: Canavia Transit Inc. Project: Victoria STOLport, Montreal, Que.

Load Test No.: 4A - Surface Location: E 121+80 N 6+40

Date of Test: December 3, 1982 Temperature: 9 to 12°C

Equipment: 254 mm Ø plate, various shims

Equipment Dead Weight: 0.7 kN

LOAD NO.	LOAD			DEFLECTION		
	DIAL (kN)	DEAD WEIGHT (kN)	CORRECTED LOAD (kN)	DIAL (mm)	DIAL CORRECTION (mm)	TRUE DEFLECTION (mm)
Seating Load	24.6	0.7				
Zero Load	12.3	"	13.0	0		
1	24.6	"	25.3	0.401	0.340	0.741
2	36.9	"	37.6	0.787	"	1.127
3	49.2	"	49.9	1.130	"	1.470
4	73.7	"	74.4	1.791	"	2.130
5	98.3	"	99.0	2.388	"	2.728
6	122.9	"	123.6	3.124	"	3.464
7	147.5	"	148.2	3.924	"	4.264

Dial Correction is calculated as per Figure 3-B, Appendix B, Document AK-68-31 prepared by Transport Canada. This figure is added to the dial reading to obtain the true deflection.

INSPEC-SOL INC.

Report No. 310C-5457 Enclosure No B-13

NON-REPETITIVE LOAD TEST DATA SHEET

Client: Canavia Transit Inc. Project: Victoria STOLport, Montreal, Que.

Load Test No.: 4B - Surface Location: E 120+80 N 6+40

Date of Test: December 3, 1982 Temperature: 13 to 14°C

Equipment: 610, 432, 305, 254 mm Ø plates, various shims

Equipment Dead Weight: 1.7 kN

LOAD NO.	LOAD			DEFLECTION		
	DIAL (kN)	DEAD WEIGHT (kN)	CORRECTED LOAD (kN)	DIAL (mm)	DIAL CORRECTION (mm)	TRUE DEFLECTION (mm)
Seating Load	34.4	1.7	36.1			
Zero Load	17.2	"	18.9	0		
1	19.7	"	21.4	0.143	0.035	0.178
2	39.3	"	41.0	0.315	"	0.350
3	59.0	"	60.7	0.497	"	0.532
4	78.6	"	80.3	0.670	"	0.705
5	98.3	"	100.0	0.829	"	0.864
6	122.9	"	124.6	1.053	"	1.088
7	147.5	"	149.2	1.260	"	1.295
8	172.0	"	173.7	1.489	"	1.524
9	196.6	"	198.3	1.703	"	1.738
10	221.2	"	222.9	1.912	"	1.947

Dial Correction is calculated as per Figure 3-B, Appendix B, Document AK-68-31 prepared by Transport Canada. This figure is added to the dial reading to obtain the true deflection.

INSPEC-SOL INC.

Report No. 310C-5457

Enclosure No.B-14

NON-REPETITIVE LOAD TEST DATA SHEET

Client: Canavia Transit Inc. Project: Victoria STOLport, Montreal, Que.

Load Test No.: 4C - Subgrade Location: E 120+80 N 6+40

Date of Test: December 3, 1982 Temperature: 8 to 10°C

Equipment: 254 mm Ø plate, various shims

Equipment Dead Weight: 0.7 kN

LOAD NO.	LOAD			DEFLECTION		
	DIAL (kN)	DEAD WEIGHT (kN)	CORRECTED LOAD (kN)	DIAL (mm)	DIAL CORRECTION (mm)	TRUE DEFLECTION (mm)
Seating Load	24.6	0.7	25.3			
Zero Load	12.3	"	13.0	0		
1	24.6	"	25.3	0.142	0.230	0.372
2	39.3	"	40.0	0.429	"	0.659
3	59.0	"	59.7	0.737	"	0.967
4	78.6	"	79.3	1.092	"	1.322
5	98.3	"	99.0	1.494	"	1.724
6	122.9	"	123.6	1.842	"	2.072
7	147.5	"	148.2	2.220	"	2.450

Dial Correction is calculated as per Figure 3-B, Appendix B, Document AK-68-31 prepared by Transport Canada. This figure is added to the dial reading to obtain the true deflection.

INSPEC·SOL INC.

Report No. 310C-5457

Enclosure No.B-15

NON-REPETITIVE LOAD TEST DATA SHEET

Client: Canavia Transit Inc. Project: Victoria STOLport, Montreal, Que.

Load Test No.: 5A - Surface Location: E 122+00 N 7+25

Date of Test: December 3, 1982 Temperature: 12°C

Equipment: 254 mm Ø plate, various shims

Equipment Dead Weight: 0.7 kN

LOAD NO.	LOAD			DEFLECTION		
	DIAL (kN)	DEAD WEIGHT (kN)	CORRECTED LOAD (kN)	DIAL (mm)	DIAL CORRECTION (mm)	TRUE DEFLECTION (mm)
Seating Load	24.6	0.7	25.3			
Zero Load	12.3	"	13.0	0		
1	19.7	"	20.4	0.533	1.0	1.533
2	39.3	"	40.0	2.730	"	3.730
3	49.2	"	49.9	3.450	"	4.450
4	68.8	"	69.5	5.156	"	6.156

Dial Correction is calculated as per Figure 3-B, Appendix B, Document AK-68-31 prepared by Transport Canada. This figure is added to the dial reading to obtain the true deflection.

INSPEC-SOL INC.

Report No. 310C-5457 Enclosure No.B-16

NON-REPETITIVE LOAD TEST DATA SHEET

Client: Canavia Transit Inc. Project: Victoria STOLport, Montreal, Que.

Load Test No.: 5B - Surface Location: E 122+00 N 7+25

Date of Test: December 3, 1982 Temperature: 12°C.

Equipment: 610, 432, 305, 254 mm Ø plates, various shims

Equipment Dead Weight: 1.7 kN

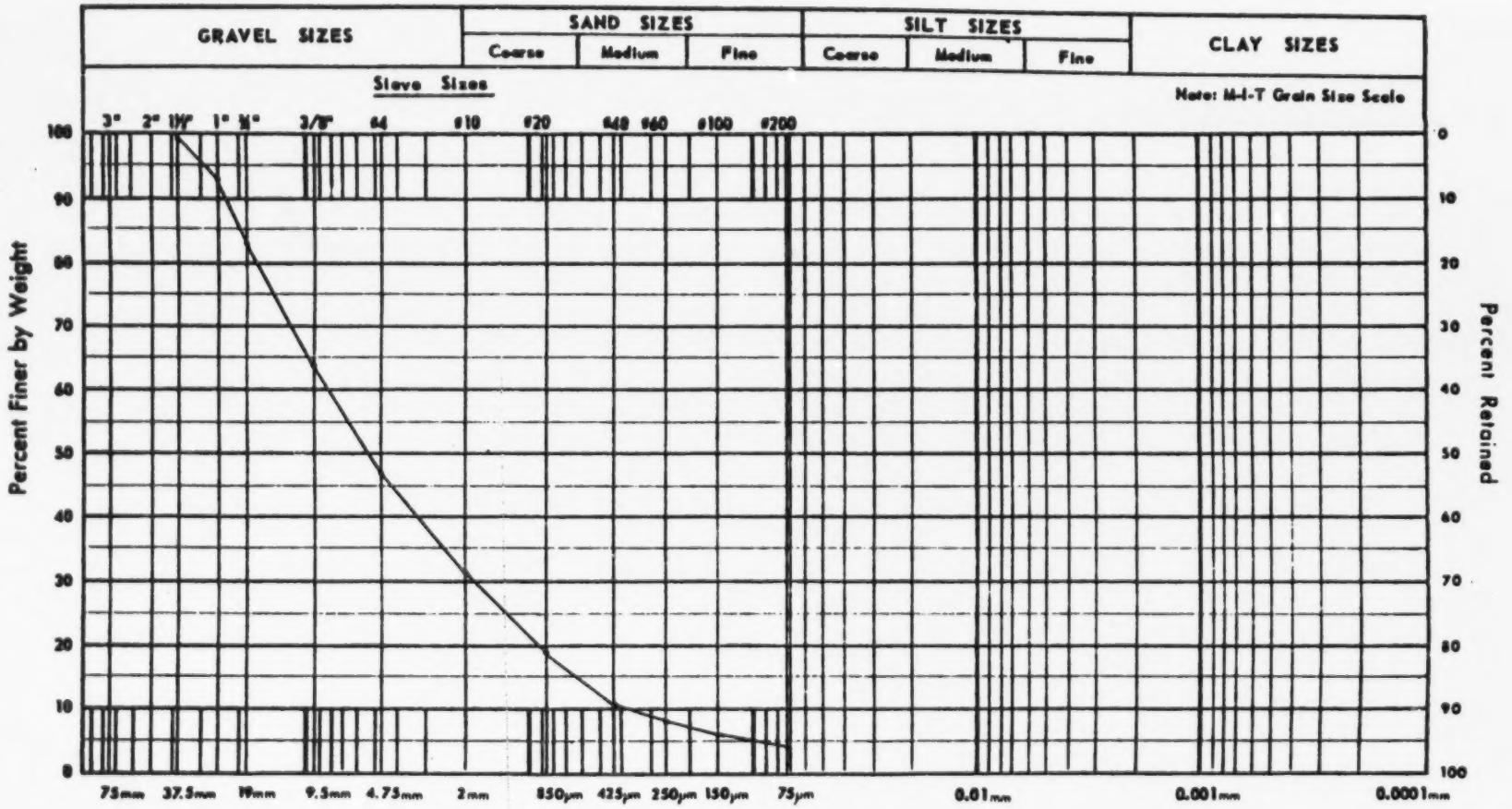
LOAD NO.	LOAD			DEFLECTION		
	DIAL (kN)	DEAD WEIGHT (kN)	CORRECTED LOAD (kN)	DIAL (mm)	DIAL CORRECTION (mm)	TRUE DEFLECTION (mm)
Seating Load		1.7				
Zero Load	12.3	"	14.0			
1	24.6	"	26.3	0.610	0.350	0.960
2	49.2	"	50.9	1.422	"	1.772
3	73.7	"	75.4	2.108	"	2.458
4	98.3	"	100.0	2.794	"	3.144
5	122.9	"	124.6	3.785	"	4.135

Dial Correction is calculated as per Figure 3-B, Appendix B, Document AK-68-31 prepared by Transport Canada. This figure is added to the dial reading to obtain the true deflection.

INSPEC-SOL INC.

INSPEC-SOL INC.

GRAIN SIZE DISTRIBUTION



CLIENT: Canavia Transit Inc./City Centre Airways Ltd.

MATERIAL: 0-38 mm crushed stone

PROJECT: Montreal STOLport
Base Course
Load Test No. 4

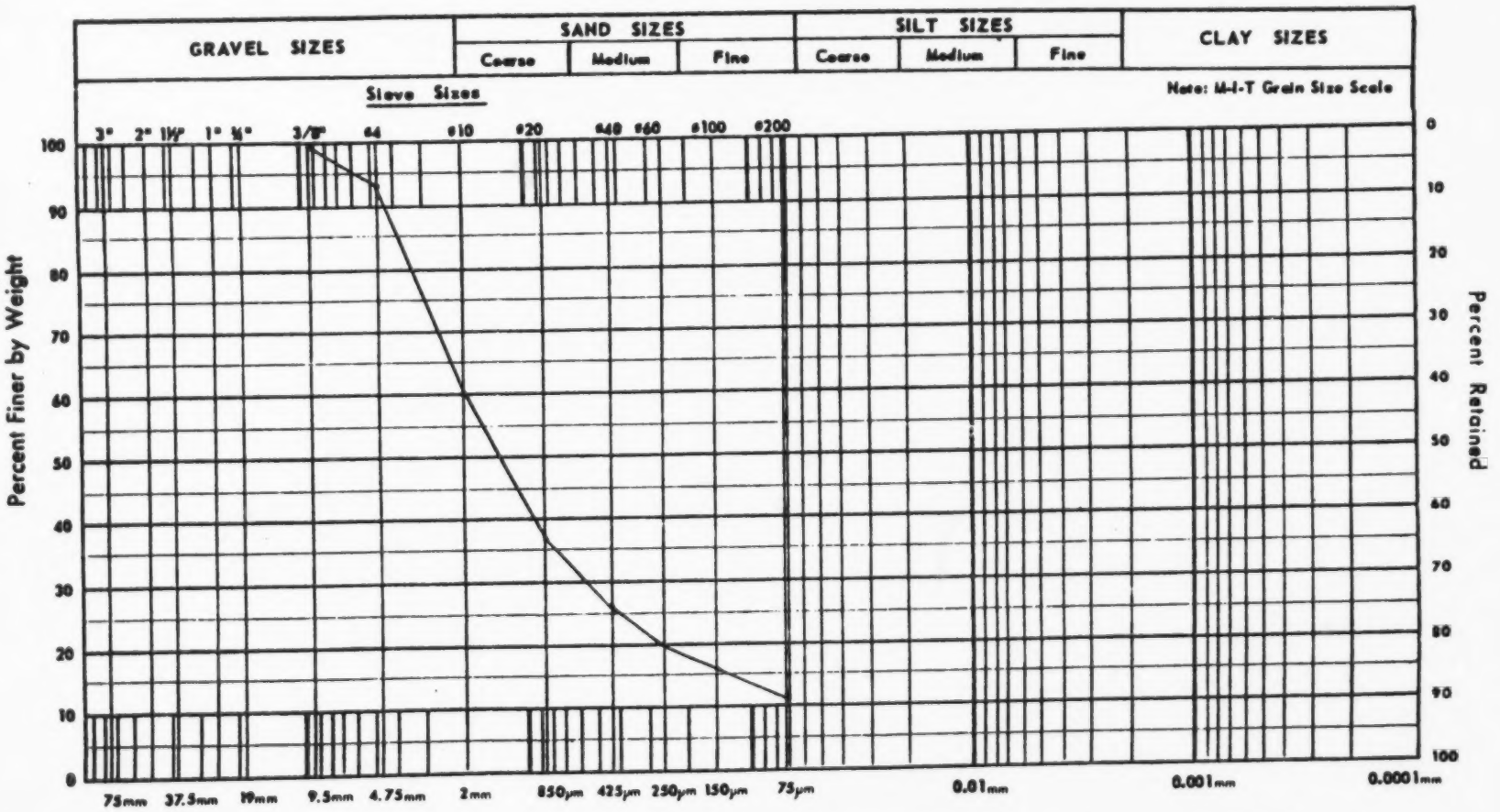
TEST DATE: December 10, 1982

Report No. 310C-5457

Enclosure No. B-17

INSPEC-SOL INC.

GRAIN SIZE DISTRIBUTION



CLIENT: Canavia Transit Inc. /City Centre Airways Ltd.

MATERIAL: Screenings (0-10 mm)

PROJECT: Montreal STOLport

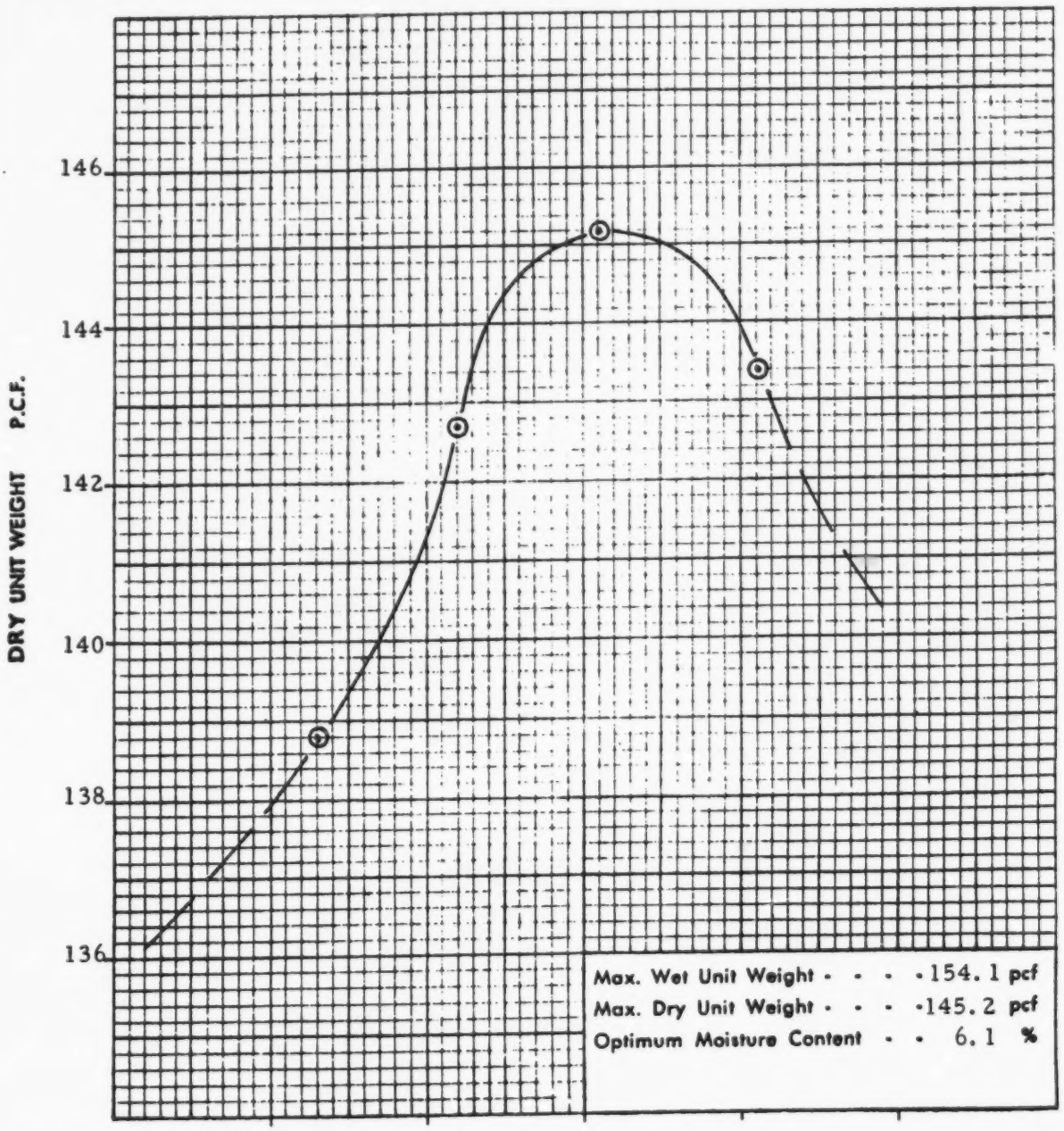
TEST DATE: December 8, 1982

Sub-base
Load Test No. 4

Report No. 310C-5457

Enclosure No. B-18

MODIFIED PROCTOR TEST



CLIENT Canavia Transit Inc. /City Centre Airways Ltd.

PROJECT Montreal STOLport

MATERIAL 0-38 mm crushed stone (tested on 0-19 mm)

TEST DATE December 10, 1982

Base Course
Load Test No. 4 - Taxiway
Wet in-situ density 134.2 P.C.F. at -3"

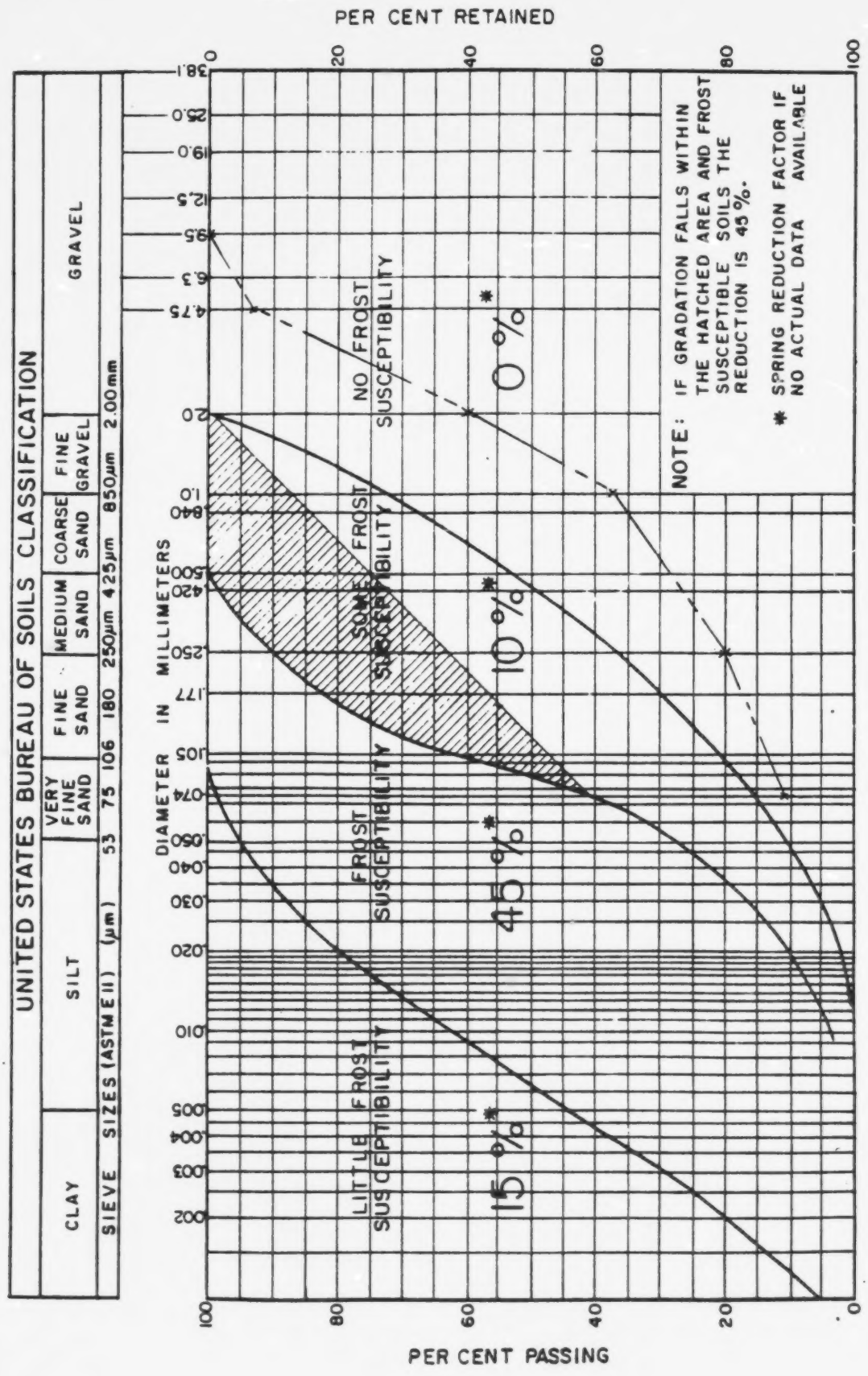
INSPEC-SOL INC.

CANAVIA TRANSIT INC.

Montreal STOLport
Asphalt Thicknesses

Load Test No. 1	57.0	60.3	60.3	57.0	Average 58.65 mm (2.312")
Load Test No. 2	76.2	66.7	79.4	69.8	Average 73.0 mm (2.875")
Load Test No. 3	66.7	57.2	60.3	63.5	Average 61.9 mm (2.44")
Load Test No. 4	60.3	60.3	60.3	60.3	Average 60.3 mm (2.375")
Load Test No. 5	63.5	57.2	66.7	73.0	Average 65.1 mm (2.56")

FIGURE 1


SPRING REDUCTION FACTOR DETERMINATION
PER CENT RETAINED
PER CENT PASSING
DIAMETER IN MILLIMETERS
UNITED STATES BUREAU OF SOILS CLASSIFICATION
CLAY
SILT
VERY FINE SAND
FINE SAND
MEDIUM SAND
COARSE SAND
FINE GRAVEL
GRAVEL
SIEVE SIZES (ASTM E11) (μm) 53 75 106 180 250μm 425μm 850μm 2.00mm
38.1
25.0
19.0
12.5
9.5
6.3
4.75
2.0
1.0
840
500
420
250
177
105
074
050
040
030
020
010
005
004
003
002
NO FROST SUSCEPTIBILITY
SOME FROST SUSCEPTIBILITY
FROST SUSCEPTIBILITY
LITTLE FROST SUSCEPTIBILITY
0 %
10 %
45 %
15 %
NOTE: IF GRADATION FALLS WITHIN THE HATCHED AREA AND FROST SUSCEPTIBLE SOILS THE REDUCTION IS 45%.
* SPRING REDUCTION FACTOR IF NO ACTUAL DATA AVAILABLE

ASTM AMERICAN NATIONAL STANDARD

ASTM D 1195 - 64 (Reapproved 1977)

Standard Method for

REPETITIVE STATIC PLATE LOAD TESTS OF SOILS AND FLEXIBLE PAVEMENT COMPONENTS, FOR USE IN EVALUATION AND DESIGN OF AIRPORT AND HIGHWAY PAVEMENTS[1]

This standard is issued under the fixed designation D 1195, the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval.

1. Scope

1.1 This method covers a procedure for making repetitive static plate load tests on subgrade soils and flexible pavement components, in either the compacted condition or the natural state, and is to provide data for use in the evaluation and design of rigid and flexible-type airport and highway pavements.

2. Definitions

2.1 *deflection*—the amount of downward vertical movement of a surface due to the application of a load to the surface.

2.2 *residual deflection*—the difference between original and final elevations of a surface resulting from the application and removal of one or more loads to and from the surface.

2.3 *rebound deflection*—the amount of vertical rebound of a surface that occurs when a load is removed from the surface.

3. Apparatus

3.1 *Loading Device*—A truck or trailer or a combination of both a tractor-trailer, an anchored frame, or other structure loaded with sufficient weight to produce the desired reaction on the surface under test. The supporting points (wheels in the case of a truck or trailer) shall be at least 8 ft (2.4 m) from the circumference of the largest diameter plate being used.

3.2 *Hydraulic Jack Assembly*, with a spherical bearing attachment, capable of applying and releasing the load in increments. The jack shall have sufficient capacity for applying the maximum load required, and shall be equipped with an accurately calibrated gage that will indicate the magnitude of the applied load.

3.3 *Bearing Plates*—A set of circular steel bearing plates not less than 1 in. (25.4 mm) in thickness, machined so that they can be arranged in pyramid fashion to ensure rigidity, and having diameters ranging from 6 to 30 in. (152 to 762 mm). The diameters of adjacent plates in the pyramid arrangement shall not differ by more than 6 in.

NOTE 1—A minimum of four different plate sizes is recommended for pavement design or evaluation purposes. For evaluation purposes alone, a single plate may be used, provided that its area is equal to the tire-contact area corresponding to what may be considered as the most critical combination of conditions of wheel load and tire pressure. For the purpose of providing data indicative of bearing index (for example, the determination of relative subgrade support throughout a period of a year), a single plate of any selected size may be used.

3.4 *Dial Gages*, two or more, graduated in units of 0.001 in. (0.03 mm) and capable of recording a maximum deflection of 1 in. (25 mm) or other equivalent deflection-measuring devices.

3.5 *Beam for Mounting Dial Gages*—A beam upon which the dial gages shall be mounted. The beam shall be a 2½-in. standard black pipe or a 3 by 3 by ¼-in. (76 by 76 by 6-mm) steel angle, or equivalent. It shall be at least 18 ft (5.5 m) long and shall rest on

[1] This method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock.

Current edition approved Aug. 31, 1964. Originally issued 1952. Replaces D 1195 - 57.

supports located at least 8 ft (2.4 m) from the circumference of the bearing plate or nearest wheel or supporting leg. The entire deflection measuring system shall be adequately shaded from direct rays of the sun.

3.6 *Miscellaneous Tools*, including a spirit level, for preparation of the surface to be tested and for operation of the equipment.

4. Procedure

4.1 Carefully center a bearing plate, of the selected diameter, under the jack assembly. Set the remaining plates of smaller diameter concentric with, and on top of, the bearing plate. Set the bearing plate level in a thin bed of a mixture of sand and plaster of Paris, of plaster of Paris alone, or of fine sand, using the least quantity of materials required for uniform bearing. To prevent loss of moisture from the subgrade during the load test, cover the exposed subgrade to a distance of 6 ft (1.8 m) from the circumference of the bearing plate with a tarpaulin or waterproof paper.

4.2 Where unconfined load tests are to be made at a depth below the surface, remove the surrounding material to provide a clearance equal to one and one-half plate diameters from the edge of the bearing plate. For confined tests, the diameter of the excavated circular area shall be just sufficient to accommodate the selected bearing plate.

4.3 Use a sufficient number of dial gages, so located and fixed in position as to indicate the average vertical movement of the bearing plate. When using two dial gages, they shall be set near each extremity of a diameter of the bearing plate, 1 in. (25.4 mm) from the circumference. When three gages are employed, they shall be set at an angle of 120 deg from each other, and equidistant from the circumference of the bearing plate. Each individual set of readings shall be averaged, and this value is recorded as the average settlement reading.

4.4 After the equipment has been properly arranged, and with all of the dead load (jack, plates, etc.) acting, seat and bearing plate and assembly by the quick application and release of a load sufficient to produce a deflection of not less than 0.01 in. (0.25 mm) nor more than 0.02 in. (0.51 mm) as indicated by the dial gages. When the dial needles come to rest following the release of this load, reseat the plate by applying one half of the recorded load producing the 0.01 to 0.02-in. deflection. When the dial needles have again come to rest, set each dial accurately at its zero mark.

NOTE 2—The use of additional dial gages, placed on the surface of the material being tested at one half, one, and one and one-half, etc, bearing-plate diameters from the edge of the bearing plate, is optional.

4.5 Apply a load giving a deflection of about 0.04 in. (1.0 mm), start a stop watch, and maintain the same load constantly until the rate of deflection is 0.001 in. (0.03 mm) per min or less for three successive minutes. Then completely release the load, and observe the rebound until the rate of recovery is 0.001 in. per min or less, for three successive minutes. Apply and release the same load in this manner six times. Record the readings of the dial gages resting on the bearing plate at the end of each minute; record the readings of the dial gages set beyond the perimeter of the bearing plate just before the application, and just before the release of load, for each repetition. To ensure good contact between the gages and the bearing plate or other surface on which they are resting, briefly buzz an electric bell attached to the deflection beam, 10 s before the dial gages are to be read.

4.6 Increase the load to give a deflection of about 0.2 in. (5.1 mm), and proceed as directed in 4.5.

4.7 Increase the load to give a deflection of about 0.4 in. (10.2 mm), and proceed as directed in 4.5.

4.8 In all cases the standard end point shall be a rate of 0.001 in. (0.03 mm) min or less for three successive minutes.

4.9 From a thermometer suspended near the bearing plate, read and record the air temperature at half-hour intervals.

5. Record of Tests

5.1 In addition to the continuous listing of all load, deflection, and temperature data, as prescribed in Section 3, a record shall also be made of all associated conditions and observations pertaining to the test, including the following:

Enclosure No. B-24

5.1.1 Date,

5.1.2 Time of beginning and completion of test,

5.1.3 List of personnel,

5.1.4 Weather conditions,

5.1.5 Any irregularity in routine procedure,

5.1.6 Any unusual conditions observed at the test site, and

5.1.7 Any unusual observations made during the test.

6. Calculation and Plotting of Load-Deflection Relationships

6.1 For each repetition of each load, determine the deflection at which the rate of deflection is exactly 0.001 in. (0.03 mm)/min. This is termed end point deflection and can be determined with sufficient accuracy from visual inspection of the deflection data for each repetition of load recorded.

6.2 Correct the recorded loads, as read from the pressure gage of each hydraulic jack employed, by means of the calibration curve for each jack and pressure gage used.

6.3 Determine graphically the zero point corrections for both applied load and deflection. This requires taking into account the weight of the hydraulic jack, that of the pyramid of bearing plates, etc., and that of the corrected jack loads at which the dial gages were set to zero at the beginning of the test.

6.4 Plot the corrected deflection at which the rate of deflection is exactly 0.001 in. (0.03 mm)/min *versus* the number of repetitions of each corrected load. Similar graphs may be prepared in which corrected residual deflection and rebound deflection are plotted *versus* the number of repetitions of each corrected load.

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This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 1916 Race St., Philadelphia, Pa. 19103, which will schedule a further hearing regarding your comments. Failing satisfaction there, you may appeal to the ASTM Board of Directors.

ASTM AMERICAN NATIONAL STANDARD

ASTM D 1196 - 64 (Reapproved 1977)

Standard Method for

NONREPETITIVE STATIC PLATE LOAD TESTS OF SOILS AND FLEXIBLE PAVEMENT COMPONENTS, FOR USE IN EVALUATION AND DESIGN OF AIRPORT AND HIGHWAY PAVEMENTS[1]

This standard is issued under the fixed designation D 1196; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval.

1. Scope

1.1 This method covers the making of nonrepetitive static plate load tests on subgrade soils and flexible pavement components, in either the compacted condition or the natural state, and provides data for use in the evaluation and design of rigid and flexible-type airport and highway pavements.

2. Definitions

2.1 *deflection*—the amount of downward vertical movement of a surface due to the application of a load to the surface.

2.2 *residual deflection*—the difference between original and final elevations of a surface resulting from the application and removal of one or more loads to and from the surface.

2.3 *rebound deflection*—the amount of vertical rebound of a surface that occurs when a load is removed from the surface.

3. Apparatus

3.1 *Loading Device*—A truck or trailer or a combination of both, a tractor-trailer, an anchored frame, or other structure loaded with sufficient weight to produce the desired reaction on the surface under test. The supporting points (wheels in the case of a truck or trailer) shall be at least 8 ft (2.4 m) from the circumference of the largest diameter bearing plate being used.

3.2 *Hydraulic Jack Assembly*, with a spherical bearing attachment, capable of applying and releasing the load in increments. The jack shall have sufficient capacity for applying the maximum load required, and shall be equipped with an accurately calibrated gage that will indicate the magnitude of the applied load.

3.3 *Bearing Plates*—A set of circular steel bearing plates not less than 1 in. (25.4 mm) in thickness, machined so that they can be arranged in pyramid fashion to ensure rigidity, and having diameters ranging from 6 to 30 in. (152 to 762 mm). The diameters of adjacent plates in the pyramid arrangement shall not differ by more than 6 in.

NOTE 3—A minimum of four different plate sizes is recommended for pavement design or evaluation purposes. For evaluation purposes alone, a single plate may be used, provided that its area is equal to the tire-contact area corresponding to what may be considered as the most critical combination of conditions of wheel load and tire pressure. For the purpose of providing data indicative of bearing index (for example, the determination of relative subgrade support throughout a period of a year), a single plate of any selected size may be used.

3.4 *Dial Gages*, two or more, graduated in units of 0.001 in. (0.03 mm) and capable of recording a maximum deflection of 1 in. (25.4 mm) or other equivalent deflection-measuring devices.

3.5 *Deflection Beam*, upon which the dial gages shall be mounted. The beam shall be a 2½-in. standard black pipe or a 3 by 3 by

[1] This method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock.

Current edition approved Aug. 31, 1964. Originally issued 1952. Replaces D 1196 - 57.

¼-in. (76 by 76 by 6-mm) steel angle, or equivalent. It shall be at least 18 ft (5.5 m) long and shall rest on supports located at least 8 ft (2.4 m) from the circumference of the bearing plate or nearest wheel or supporting leg. The entire deflection measuring system shall be adequately shaded from direct rays of the sun.

3.6 *Miscellaneous Tools*, including a spirit level, for preparation of the surface to be tested and for operation of the equipment.

4. Procedure

4.1 Carefully center a bearing plate of the selected diameter under the jack assembly. Set the remaining plates of smaller diameter concentric with, and on top of, the bearing plate. Set the bearing plate level in a thin bed of a mixture of sand and plaster of paris, of plaster of paris alone, or of fine sand, using the least quantity of materials required for uniform bearing. To prevent loss of moisture from the subgrade during the load test, cover the exposed subgrade to a distance of 6 ft (1.8 m) from the circumference of the bearing plate with a tarpaulin or waterproof paper.

4.2 Where unconfined load tests are to be made at a depth below the surface, remove the surrounding material to provide a clearance equal to one and one-half bearing plate diameters from the edge of the bearing plate. For confined tests the diameter of the excavated circular area shall be just sufficient to accommodate the selected bearing plate.

4.3 Use a sufficient number of dial gages, so located and fixed in position as to indicate the average deflection of the bearing plate. When using two dial gages, they shall be set near each extremity of a diameter of the bearing plate, 1 in. (25.4 mm) from the circumference. When three gages are employed, they shall be set at an angle of 120 deg from each other, and equidistant from the circumference of the bearing plate. Each individual set of readings shall be averaged, and this value is recorded as the average settlement reading.

4.4 After the equipment has been properly arranged, with all of the dead load (jack, plates, etc.) acting, seat the bearing plate and assembly by the quick application and release of a load sufficient to produce a deflection of not less than 0.01 in. (0.25 mm) nor more than 0.02 in. (0.51 mm), as indicated by the dials. When the dial needles come to rest following release of this load, reseat the plate by applying one half of the recorded load producing the 0.01 to 0.02-in. deflection. When the dial needles have then again come to rest, set each dial accurately at its zero mark.

4.5 Apply loads at a moderately rapid rate in uniform increments. The magnitude of each load increment shall be small enough to permit the recording of a sufficient number of load-deflection points to produce an accurate load-deflection curve (not less than six). After each increment of load has been applied, allow its action to continue until a rate of deflection of not more than 0.001 in. (0.03 mm)/min has been maintained for three consecutive minutes. Record load and deflection readings for each load increment. Continue this procedure until the selected total deflection has been obtained, or until the load capacity of the apparatus has been reached, whichever occurs first. At this point, maintain the load until an increased deflection of not more than 0.001 in./min for three consecutive minutes occurs. Record the total deflection, after which release the load to load at which the dial gages were set at zero, and maintain this zero-setting load until the rate of recovery does not exceed 0.001 in. for three consecutive minutes. Record the deflection at the zero-setting load.

4.6 From a thermometer suspended near the bearing plate, read and record the air temperature at half-hour intervals.

5. Record of Tests

5.1 In addition to the continuous listing of all load, deflection, and temperature data, as prescribed in Section 3, a record shall also be made of all associated conditions and observations pertaining to the test, including the following:

5.1.1 Date,

5.1.2 Time of beginning and completion of test,

5.1.3 List of personnel,

5.1.4 Weather conditions,

5.1.5 Any irregularity in routine procedure,

5.1.6 Any unusual conditions observed at

the test site, and

5.1.7 Any unusual observations made during the test.

6. Calculation and Plotting of Load-Deflection Relationships

6.1 From the data obtained by the procedure described under 3.5, plot the total or unit load in pounds-force (or newtons) for each increment against the corresponding settlement in inches. Also plot the recovery after full release of load. Correction should be made for the zero deflection point, taking into account the dead weight of the equipment and the seating load. From this graph, the relation of load and total deflection for that load, and the relation of rebound and residual deflection for the maximum load used, may be obtained.

The American Society for Testing and Materials takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 1916 Race St., Philadelphia, Pa. 19103, which will schedule a further hearing regarding your comments. Failing satisfaction there, you may appeal to the ASTM Board of Directors.

APPENDIX II

REVIEW OF GAS MONITORING AND ENVIRONMENTAL REQUIREMENTS FOR STOLPORT SITE - VICTORIA CARPARK, MONTREAL

A Report Prepared for:

Canavia Transit Inc./
City Centre Airways Ltd.
Toronto, Ontario

by

IEC Beak Consultants Ltd.

2156.1
January 1983

Prepared by:

A.D. FitzGerald
Vice-President, Engineering Services

Approved by:

D.O. Mallen
Managing Principal

INTRODUCTION

In the mid 1970's experimental Short Take-off and Landing (STOL) passenger services were operated between Montreal and Ottawa. The Montreal terminus was the former Victoria Carpark (Expo '67) located near the Victoria bridge between the Bonaventure Autoroute and CN rail maintenance yards.

The site was used, from before the early 1900's until 1965, as a dump for garbage, refuse, building debris, and industrial waste and included substantial shore dumping with subsequent shoreline shift. The nature of the underlying material was such that over the years decomposition produced continued land settlements and methane gas generation. These phenomena required particular design considerations when the experimental STOL facilities were built. Included were impermeable membranes, ventilation systems in and around surface structures, and methane gas collection, venting and flaring.

A study of the land settlement and gaseous emission aspects of the site was undertaken by Beak Consultants Ltd. in 1977-78 for Transport Canada. In depth investigations included:

- characterization of subsurface material
- land settlement
- gas production rates, monitoring, and control methodology
- construction methods for asphalted areas and buildings.

At the time of the study experimental STOL services had ceased and the feasibility of more permanent services were being investigated. Feasibility investigations have continued since then and Canavia Transit Inc/City Center Airways Ltd. are now undertaking studies on the costs of upgrading the site and constructing facilities such as a terminal and a maintenance T-hangar. These would satisfy a STOL service between Montreal, Ottawa and Toronto.

To assist in developing costs and required construction methodology a new study has now been funded by the Transportation Development Centre, Montreal to review and update the results of the 1977-78 study. Specifically the following work tasks were identified.

1. Topographic survey of runways, taxiways, and aprons to determine settlements since the previous study.
2. Analysis of settlement rates.
3. Test and evaluate strengths of the above areas and develop load/deflection curves.
4. Compare and evaluate settlements with respect to subsurface material decomposition and gas generation, and recommend programs for ongoing and future work respecting gas monitoring and environmental activities.
5. Evaluate existing building piles and concrete rafts.

Tasks 1, 2 and 3 have been undertaken by Inspec-Sol Inc. while Task 5 has been undertaken by Gionet, Mellor, Liebich Associates. IEC BEAK Consultants Ltd. has been retained to carry out Task 4. Results of the other tasks are being presented in separate reports; this report addresses the objectives of Task 4.

APPROACH

The 1977-78 study included extensive assessments of:

- land settlement and predictions of ongoing site movement
- subsurface material characterization
- gaseous emission characterization and predictions for future rates of discharge
- recommendations for construction features necessary to ensure a safe site and buildings vis-a-vis gas accumulations, explosivity aspects, etc.

IEC BEAK's approach to the current study includes: reviewing the results and recommendations of the previous study; comparing new settlement measurements with those projected in the 1977-78 report; and assessing whether the recommendations of the previous study stand or whether modifications to those recommendations are in order.

RESULTS

Measurements of land settlement that has occurred between September, 1978 and November 1982 have been taken by Inspec-Sol and are presented in their separate report. The amount of land settlement and subsidence over the recent four years has

occurred at a lower rate than projected in the 1978 study. At the time of that study a settlement rate of 1"-2"/year was expected over the site. The recent measurements show that settlement has continued, however the rate for the area studied appears to be in the order of 1/2-3/4 of that projected in the 1978 study. This study was limited to the runway and its immediate environs, and selected spots in the areas of the taxiway, apron, and former buildings.

Continued settlement is expected, however these new results show the rate to be decreasing. The magnitude of settlement in the long run therefore may not be as great as formerly projected. Since settlement continues, indicating ongoing decomposition of the underlying material, gaseous emissions have and are expected to continue. Measurements of gaseous emissions were not part of the study at this time however there was evidence of continued emissions through detectable odour at points on the site, specifically at formerly active flares and in the vicinity of the building foundations. The rate of gas emission can be expected to decline as the rate of land settlement through decomposition of material declines.

Land settlement in the area of the former hangar would appear to be taking place at a higher rate than other areas. This was noted in the previous study and observation of the site around the hangar foundation confirms a continued comparatively higher rate, in the order of 2"-3"/year. Settlement rates here will likely decline, as is the case for other parts of the site, however a higher rate is expected to continue and may pose some difficulties in aircraft movements in and out of the proposed T-hangar. Continued building of access ramps on a regular basis will undoubtedly be required. An option for consideration could include selection of a site for the T-hangar elsewhere on the property where rates of land settlement are considerably less than those observed at the existing foundation location.

In the vicinity of the former terminal building settlement rates presently appear to be in the order of 1"/year. While still requiring maintenance of accessability on a regular basis the costs and difficulties of doing so are not as significant as the effort required for the hangar.

The previous report has been reviewed in detail, particularly those portions containing recommendations pertaining to building structures and safety. In light of the expected ongoing gaseous emissions this review has resulted in no changes to previous recommendations. The same concerns will apply and design features should include:

- building positive ventilation
- ensuring integrity of building slabs with no cracks and openings
- ventilated breezeways
- flexible pavements
- window seals
- fireproof and static resistant furnishings
- lightening and fire sprinkler protection
- flexible service connections
- upgraded electrical requirements and
- state-of-the-art continuous detection equipment.

Details of these recommendations are contained in the BEAK report:

Environmental Engineering Study
STOLport Site
Victoria Carpark-Montreal
January 1979

Ongoing gas monitoring and environmental requirements have also been reviewed. Section 5.6.2 of the 1978 report recommended a regular ongoing monitoring program from which data would be used to identify the most active areas which could then be provided with gas control or flaring devices, should they be necessary. This program appears to not have been implemented. Since upgrading of the site to an active STOL operation anpears to be closer to reality it is recommended that consideration to be given to now implementing the 1978 gas monitoring recommendations. The program as recommended in 1978 included monitoring at boreholes drilled in 1978 and flares which had been installed before experimental STOL services. Boreholes recommended for monitoring included numbers 2, 3, 4, 6, 7, 9, 10, 12, 14, and 16. Flare points for monitoring included numbers 1, 5, 9, 11, 21, and 23. Borehole tubing and surface facilities may or may not be intact at this time and each would now require an inspection to determine whether it's still suitable for monitoring, whether it can be brought back to usefulness, or whether

new boreholes have to be installed. Certainly all boreholes have experienced land subsidence around the tubing at ground level and a new concrete seal would be required to stop gas leakage. A copy of the sketch contained in the 1978 report showing borehole monitoring facilities has been attached to this report.

Supporting this recommendation for gas monitoring from an environmental point of view, is recent interest and concern expressed by the Environmental Protection Service, Quebec Region, that the dump site may be impacting on the St. Lawrence River through a movement of leachates containing toxic contaminants. The STOLport site is one of a number of dump sites on which the federal government is focusing effort in the area of receiving water contamination by toxics. Through implementation of the gas monitoring program set forth in the referenced section 5.6.2 of the previous report, an opportunity would exist to monitor leachates and groundwater in the site for those specific parameters of concern from an environmental point of view and which may require control or mitigative measures in future.

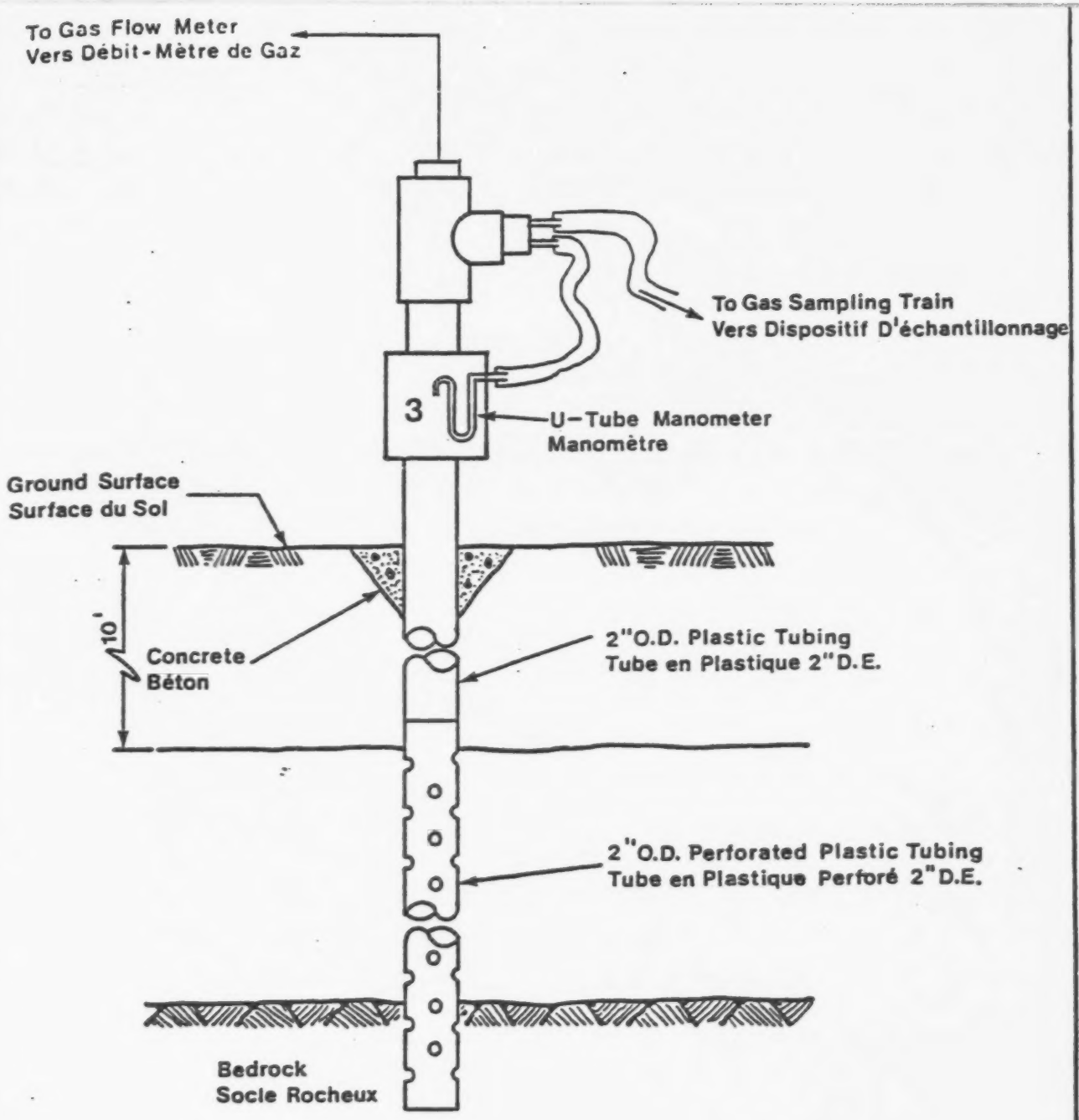
RECOMMENDATIONS

Based on this brief study and review, the following conclusions and recommendations are set forth for consideration by the proponent of the STOL service:

1. Recommendations contained in the Beak report of January 1979 with respect to gas control are in order and stand. Existing building slabs and foundations should be upgraded to include their original gas control devices, ensuring integrity of membranes and floor slabs, and including positive pressure systems.

2. Recommendations in the 1979 report vis-a-vis gas control and monitoring in building structures are applicable, without change, to the new proposed buildings.

3. Site gas monitoring facilities were recommended in 1979, and have not been implemented. These are again recommended, both for gaseous emission monitoring and for potential measurement of leachate characteristics, due to recent concern for possible receiving water contamination.



BOREHOLE GAS COLLECTION SYSTEM

SYSTEME DE COLLECTION DES GAZ AUX TROUS DE FORAGE

TRANSPORT CANADA AIR	TRANSPORTS CANADA AIR		BY BG DATE FEB 78 DWG. NO. A1322-5	FIG. 5.5

APPENDIX III

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Report on:

FOUNDATION INVESTIGATION

TERMINAL AND HANGAR BUILDINGS

SIGLPORT SITE

VICTORIA CAR PARK - MONTREAL

Prepared for: CANAVIA TRANSIT INC.

By: GIONET MELLOR LIEBICH ASSOCIATES LIMITED

JANUARY 1983

Project: 7154

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1) INTRODUCTION

In November 1982, a request was made by Canavia Transit Inc. to have an evaluation made of the remaining foundations of the now demolished Stolport Terminal and hangar buildings located near the Victoria Bridge in Montreal, Quebec. These two structures were part of the original experimental Stolport facilities constructed by Transport Canada in the mid-1970's. Canavia Transit Inc., in co-operation with City Centre Airways, plans to re-instate the Stol services between Ottawa, Montreal and Toronto in the fall of 1983. To do so, it is planned to re-use the existing foundations in order to re-build a new hangar and terminal superstructure upon same. Gionet, Mellor, Liebich Ass. Ltd. were given the mandate to examine the condition of the existing foundations and to evaluate the suitability of re-using same and also to verify the condition of the membrane located below the building floor slabs which was used to control methane gas emissions emanating from the sub-strata. This report summarizes our findings and recommendations.

2) INVESTIGATION

The original structures consisted of two (2), one-storey buildings which were constructed on pile foundations. The piles were required to transmit the building foundation loads to bedrock, as the airport site is located on an abandoned garbage dump, approximately 30 feet deep. The demolition of the original superstructures left the remaining floor slabs, the floor slab support columns, pile caps and piles intact. Also remaining in the crawl space between the floor slab and pile caps, is the flexible membrane, installed to prevent methane gas from entering the building. A visual examination was made of all of the above except for the pile caps and piles which are not accessible except by removal of overburden, which was outside the scope of this report.

Transport Canada's design office in Ottawa was contacted for information relating to the design of the piles and the original construction drawings of the buildings were reviewed.

Also included in our investigation was the review of an environmental study prepared by Beak Consultants Ltd. in January 1979 on behalf of Transport Canada. This report provided background information on leachate conditions that could affect the pile foundations as well as the methane gas production problems relating to the buildings.

3) RESULTS

3.1) The original design called for the installation of treated wood bearing piles to support both the hangar and terminal buildings. Last minute delivery problems necessitated replacing wood piles with concrete filled steel piles. (224-8 5/8 ø & 57-10 3/4 ø)

3.2) Life expectancy of the concrete filled steel piles is virtually unlimited, structurally speaking, as no unexpected detrimental effects to the piles are expected from the ground-water and leachates found in the Beak study.

3.3) Visual examination of the floor slabs shows no unusual cracking, spalling or premature aging of the structural concrete.

3.4) The flexible membrane located in the crawl space below the floor slabs, which was once protected by 6 inches of sand, is now exposed due to the drastic settlement of the backfill under and around the buildings. The membrane has been damaged and deformed radically as it is now supporting large amounts of building debris disposed of in the crawl space after demolition of the building superstructures.

4) RECOMMENDATIONS

4.1) The existing foundations appear structurally sound and are therefore suitable to receive a new superstructure, providing of course, that the original design loads are not exceeded in the new design.

4.2) Before construction of any new buildings at this site, careful attention must be given to the control of methane gas emissions. Remedial action such as the re-installation of a new flexible membrane or clay seal along with some " positive - active " means of gas control (ie. mechanical ventilation) must be instituted before any structural works can be contemplated.

POOR

QUALITY

ORIGINAL